2dF–AAOmega Manual

Volume II: Support Manual

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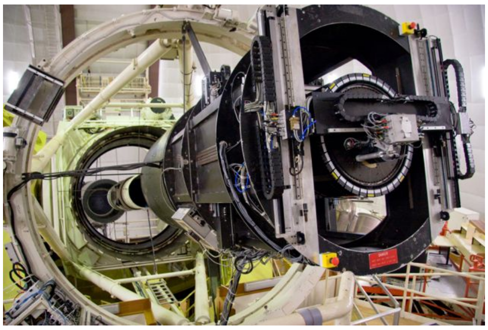
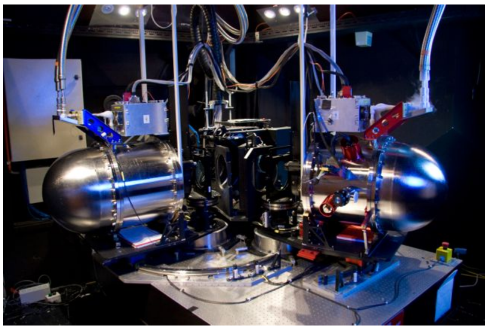

Parts of this manual:

Volume I: User Manual *Guide for astronomers and other users.*

Volume II: Support Manual

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Part VI

Support and Advanced User Tasks

This part is a section of the larger 2dF–AAOmega manual, which is available from the website.
http://www.aao.gov.au/science/instruments/current/aaomega/overview

Chapter 23

Moving Telescope between Zenith and Primary Focus Access

This section is a reminder only. Anyone who has not been explicitly instructed in the safe movement of the telescope should NOT attempt to move the telescope. If in any doubt about moving the telescope contact an AAT staff member first.

23.1 Starting the telescope in computer mode:

- Check that the Primary Focus (PF) access area is clear and it is safe to move the telescope (either down to PF access or back up to zenith).
- Make sure that there are no safety tags preventing use of the telescope on the AAT console.
- Go to the telescope console area. If BOTH the 'Oil' and 'Run' buttons on the LHS are green then skip the next two steps, the Oil pumps are already up and running.
- If the 'Oil' pumps are not already running, then press the 'OIL' button to turn on the oil pumps and wait for the 'READY' light to be illuminated.
- When the 'READY' light is illuminated press the 'RUN' light.
- Press the two buttons on the right-hand-side marked 'RA computer' and 'DEC computer' to put the RA and Dec into computer mode.
- If the telescope will be left in its new position for some time then the oil pump should be turned off **once the slew has completed**. See Section 16.2 for details.
- To move the telescope, click the relevant button (*zenith park* or *PF access*) in the console window, under the control tab. The telescope should start to move.

23.2 Shutting down the telescope

With the telescope stationary and in a position where you are unlikely to want to move it for a while it is normal to shut down the telescope and oil pumps.

- Press the two buttons marked ‘RA manual’ and ‘DEC manual’ to set the drives to manual.
- Press the ‘READY’ button to take the telescope out of ‘RUN’ mode.
- Press the ‘OIL’ button to turn off the oil pumps. Two warning alarms will sound: press the warning and interlock alarm cancel buttons.

The telescope should **not** be switched off using the ON/OFF switch, which is protected by a plastic cover

Do not leave the telescope in ‘RUN’ with the pumps running if it is not required to move the telescope (for example when configuring a field).

If working on the telescope or positioner, take the telescope out of ‘RUN’ mode (press the ‘READY’ button) and put a warning tag on the telescope.

Chapter 24

Startup and Shutdown

24.1 Starting Up `tdfct`

Typically, the AAT technicians will start the control task for you. If it is not running, you should enquire with them before starting it.

> This section is for advanced users only. If you have not done this before, seek help from AAO staff before proceeding.

The main **rules** for starting the 2dF control system are to make sure the software is in a tidy state and to start the control systems before applying power to anything. The startup procedure depends on exactly how the system was shutdown (see Section 24.2).

NOTE:
The control task cannot be run over the network, e.g. via `ssh`. Remote observing depends on a VNC connection to the observing console at the AAT.

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1. At the console for `aatxdb` in the control room, select `aatlxy` from the system chooser and log in as `aatinst`. The password is known by AAT staff. Open an `xterm` by right clicking in the background if one is not open.

2. Type `cleanup` into the `xterm` to make sure nothing has been left running.

3. Power cycle the 2dF top end using the internet power switch:

   (a) Open the web browser The power switch is bookmarked on the browser tool bar (for reference IP address for the switch is `10.88.90.66`). This should pop up a password request box. You **do not** need a password, just leave the entries blank and click OK (DO NOT click Cancel).

   (b) A web form interface to the 2dF top end network power switch will appear. Select the **Boot** radio button from the form for the `VME_Crate`, and then hit the **Apply** button to reboot the top end power supplies VME crate, and confirm.

   (c) Finally, although the system has a 2 minutes auto time out on it, click the log out button to exit the system.

4. After a clean 2dF shutdown a CCD reset is NOT required. The CCD system only needs resetting if the VME system was *Cleaned up* during shutdown or if there have been CCD problems. If you need to do this, follow these steps:

   (a) First, locate the AAO2 CCD controller VME system. It is in the control room, behind the blue screen. The system is at shoulder height, next to the network switch cabinet. There are two VME systems, the one that is currently being used for AAOmega will be noted on the control room white board.

   (b) Find the relevant reset switch. It's a big red button at the bottom of aatvme10 but only a small black lever switch for aatvme15. Both are clearly labelled with "RESET".

   (c) Press/flip this once to reset the CCD system.

5. Now wait for the two boot messages to appear on the aatlxy. The pop up window notifying the reboot of the 2dFSys will appear first, while the pop up window indicating the resetting of 2dFPos may need some time (a couple of minutes, even a bit more sometimes).[1]

6. Type **aaomega** or **hermes** (as appropriate) into the aatlxy terminal window to start the 2dF control system running. The 2dF main window will appear (see Fig. **??**).

7. To initialise all of the hardware choose the **Initialise** item from the commands menu. [2]

8. To bring up the various control windows, click the more button under the corresponding part of the system in the 2dF Main Window. The FPI window starts up minimised, and can be found in the task bar at the bottom of the screen.

[1] If the boot messages don't appear then "telnet 2dfpos" and look for "– >" which is the VXworks prompt. To exit telnet, press <Ctrl>-D and then quit. It may be necessary to start sysgo.

[2] In the event of a poor 2dF shutdown prior to this restart, it is not uncommon for the positioner to give an NVRAM error. This is normal if there has been some positioner weirdness and is actually a fibre safety feature to ensure that the software knows where the fibres physically are. Let the start up exit cleanly and then follow the steps outlined in the *Don't Panic: Survival Guide*.

24.2 Shutting down 2dF

This section is for advanced users only. If you have not done this before, seek help from AAO staff before proceeding.

NOTE:
If there have been positioning problems or errors and the gripper is carrying a fibre, then you should NOT attempt to shut down 2dF without expert technical assistance (by phone or in person).

These are the steps needed to perform a regular shutdown of 2dF:

1. From the main `tdfct` window choose the `exit` option from the *File* menu item.

    - A subsystem selection menu will appear. This allows parts of the system to be shutdown while leaving other parts running. It is generally best to just accept the defaults.
    - A number of error messages will pop up as various parts of the system lose communication with each other. Communication errors can be cleared.

2. Once all of the subtasks have exited, a small dialogue box will appear asking you to confirm the exit for the main control task.

    - There are several push-button options on the right hand side of the window. The buttons toggle select which subsystems should be *cleaned up* on shutdown. The `local system` should always be selected. The `vme` systems should be cleaned up if there has been any CCD issues (the CCD controllers will then require a reset). Finally, the instrument control computer `aaomega_server` or `hermesic2` should be cleaned up only if there have been spectrograph issues (less common).

Chapter 25

The 2dF Engineering Interface

25.1 Starting tdfeng

NOTE:
The engineering interface is automatically started with the regular instrument control interface (e.g., hermes or aaomega). These instructions are used for starting the interface on another computer, or when one wishes to start up 2dF without starting the full instrument control task, e.g., while troubleshooting. It is safe to start the instrument control tasks after starting the engineering interface.

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1. To start the engineering interface, type **tdfeng** into the aatlxy terminal window.
2. A startup dialogue window will appear. This window allows you to start the positioner or to access the running version of the positioner if someone is already running tdfeng from another computer. Then choose **ONE of the two options** below:

   a. If **NOBODY** is running tdfeng in another computer and you **did not start** the main 2dF control system, then just **click the red Start System button**.

   b. If tdfeng is running elsewhere (which very probably means that the positioner is OK and working) or you already started the main 2dF control system without any failure, **click on the Access Running button** to access to the running version of the **engineering interface**.

The engineering interface window (see Fig 10.9 in the 2dF-AAOmega Manual Volume I: User Guide) will appear.

Chapter 26

First night setup

26.1 Overview of the first night setup

There are three major components to the **2dF First Night setup**:

- Pointing model calibration (**SNAFU**, Section 26.2.2, page 15)
- Instrument axes calibration (**APOFF**, Section 26.2.1, page 14)
- Astrometric calibration (**POSCHECK**, Section 27, procedure on page 19)

All three of these must be completed to ensure good performance of 2dF on the sky. They can be completed in any order. with the same final result. Each procedure is described in the sections that follow independently for clarity. However, typically they are all done together as outlined below:

1. Before sunset, configure **Plate 0 for the POSCHECK**. Then place (another) guide fibre at the centre for the APOFF. Tumble this plate to the observing position. Repeat this setup for Plate 1.
2. Slew to a SNAFU star, focus the telescope, unpark the FPI and measure the **APOFF for Plate 0**.
3. Ask the friendly night assistant to conduct a **SNAFU** run.
4. Slew to the poscheck field. Focus the telescope accurately. Start the automatic **POSCHECK** on Plate 0. Configure Plate 1 for its poscheck field (possibly the same). Place a guide fibre at the centre of the plate.
5. When the POSCHECK on Plate 0 is complete, tumble. Unpark the FPI and measure the **APOFF for Plate 1**. Move the poscheck files for Plate 0 into place and restart/run `configure` for the first science field.
6. Start the **POSCHECK for Plate 1**. Start Plate 0 configuring the first science field.
7. When the POSCHECK in Plate 1 is complete, move the poscheck files into place, and restart `configure`.

This can be started as soon as the sky is dark enough to reliably identify stars in the FPI and guider cameras, typically just before nautical twilight ends. The efficient astronomer can usually finish all steps of the setup soon after astronomical twilight (about 45 minutes).

26.2 Pointing Calibration

The pointing model within the Telescope Control System (TCS) allows the instrument to be pointed quickly and efficiently at the astronomical field of interest. When correctly set up, the astronomer should be able to slew to a new field and the night assistant should be able to acquire the field regularly without difficulty or intervention from the astronomer. Also, some parts of the telescope pointing model are used for accurate field configuration.

Pointing calibration involves setting up the values of the parameters which determine the position of the pointing axis (**SNAFU**), and the offsets between the reference axes of the FPI camera and the two plates (**APOFF**). Although this is standard procedure for the AAT it is particularly important that it is done correctly for 2dF.

The aperture offsets (**APOFF**) values give the offsets between various axes of the instrument and telescope. Historically, these were the offsets necessary to move an object from e.g. the acquisition eyepiece or camera to the science camera or slit. In 2dF, they represent the difference between the centre of the FPI camera (defined as the **REF** axis), and the centre of the two field plates (**Plate 0** corresponding to **Axis A**, and **Plate 1** to **Axis B**). These axes are generally selected automatically by the software, but occasionally must be set manually for the desired behaviour.

26.2.1 APOFF: Measuring the FPI/Plate offsets

The **instrument APerture OFFsets (APOFFs)** define the offset between the centre of the FPI and the centre of each field plate. These are the steps to measure the APOFFs:

1. Make sure the telescope is stationary or tracking but **NOT** slewing.
2. **Place a guide fibre at the centre of the field plate:** Choose a guide fibre which is in good working order (any guide fibre other than Fibre 150, which is typically used for poschecks, will do). Use the `2dF engineering interface` (see Fig 10.9 in the 2dF-AAOmega Manual Volume I: User Guide) and follow these steps.
   (a) **Survey the gripper gantry:** Choose the menu item Plates → Survey fiducials. Select gripper gantry.
   (b) **Place the fibre:** When the survey has completed, in the Fibres menu, select move fibre.
   (c) Enter the required fibre pivot number, e.g., fibre 200, and then enter the X,Y position as 0,0.
   IMPORTANT: Make sure that **you hit return after each entry**. If not, the correct value of theta is NOT recalculated.
3. **Tumble:** From the Positioner window, click Tumble so the configured plate is in the observing position. (See § 10.3: Positioner Control in Volume I.)
4. **Slew to a SNAFU star:** Ask the friendly Night Assistant to go to a bright SNAFU star near the zenith.
5. **Set the Atmospheric Dispersion Corrector (ADC) tracking:** in the ADC Control window, select Slew to Tel Pos, then Set Tracking (see § 10.6: ADC Control for details about the ADC).
6. **Centre the FPI:** Click the Control Options button on the right side of the FPI window and choose the Centre gantry - survey check option.

7. **Centre the telescope on the star:** Set the exposure time to ∼ 0.2 seconds for a SNAFU star. Take an image with the FPI. **Accurately** (as described in Section 11.3) centre the star in the FPI CCD window: draw/drag a box around the star with the `Shift` key and then select Offset telescope to centre star from the Commands menu. Do this twice to check that the second time does not move the telescope more than ∼ 1 arcsec as shown in a FPI message window.
   NOTE: This step will not be possible if the telescope is not at least in rough focus—use the continuous FPI image mode and ask the night assistant for help. More precise focusing can be done later on a more appropriate star, as the SNAFU star may be too bright. The procedure to focus the telescope is described in § 11.4: Focusing the Telescope.

8. **Move the FPI gantry clear:** Once you are happy with the centering of the star, move the FPI clear of the fibre (Gantry Task control → Control Options → Park.

9. Your friendly night assistant should switch/check that the telescope has switched from the **REF axis** (FPI Camera) to either A or B (corresponding to Plate 0 or 1 as appropriate). The NA will start the APOFF program before using the guide buttons on the telescope console to centre the star in the guide fibre.

10. The procedure should be **repeated on the other plate**. This is a sanity check, as the APOFF for A and B should be fairly similar to each other. If they are widely different then there is something wrong. You can do it now or later if you are following the suggested optimization of the first night setup described in Section 26.1.

26.2.2 SNAFU: Measuring The Pointing Model

A careful SNAFU run will update the telescope's overall pointing model by identifying and measuring the offsets between the expected and observed positions of a series of stars identified for the purpose (SNAFU stars).

The SNAFU is a standard procedure at the AAT. It can be done either by centering the star in the FPI or on the guide fibre centered on one of the plates (the latter is more common). **Your friendly night assistant will execute the SNAFU for you**, but may ask you to centre stars in the FPI if they use that method. Between 10 and 12 SNAFU stars are used to complete this procedure.

The night assistant may want to remember that if the ADC has been placed in tracking mode (and there is little reason not to leave it there) then the ADC should be allowed a few seconds to settle at each new SNAFU star. You can help by bringing up the ADC window.

Unlike other tasks here, the SNAFU does not need to be repeated for both plates, as it only depends on the telescope.

Chapter 27

2dF Astrometric Calibration (POSCHECK)

The process of mapping the sky onto the coordinates of the field plate is accomplished through an astrometric calibration or **POSCHECK**. This section presents some background information on the process, a step by step procedure for the standard scenario, and detailed instructions for alternate situations. Additional problem solving is described in the Section 28.

If you're in a hurry, skip to the procedure described in Section 27.3 on page 19.

27.1 Background

The 2dF robot is designed to place fibres on a field plate such that the position of science fibres relative to guide fibres is highly accurate. Considering that a field plate is configured not in the observing position, that both the telescope and robot flex, and that 70 μm on the plate corresponds to 1 arcsecond on the sky, the relative positioning of the fibres must be very accurate.

To accomplish this high level of accuracy, 2dF has several tools which work together to provide relatively easy calibration of the positioning. These are

back illumination All of the fibres within 2dF can be "back illuminated" or lit via a light on the other end. This illumination allows cameras on the gantries to identify where things are, even in the dark.

fiducial fibres Embedded in each field plate are 21 fibres known as "fiducials". These fibres provide the master or fiducial coordinate system for that plate. The positions of the gantries are tied to this coordinate system by *surveying* the positions of the fiducials fibres.

gripper gantry The gripper gantry holds both the fibre button gripper, and a plate-ward facing camera. This is the gantry that does the work of positioning the fibres. It has an encoding system which provides accurate positioning across the plate. The plate-ward facing camera is used to measure both the position of the fiducial fibres and the science and guide fibres as they are moved about the plate. The gripper gantry effectively ties the fiducial coordinate system to the positioned fibre coordinates.

FPI gantry The focal plane imager or FPI gantry holds both a plate-ward facing camera and a skyward facing camera. It sits near the prime focus plane of the AAT, and uses reimaging optics to bring light from the sky into focus. Again, this gantry has an encoding system which allows it accurate relative movements. By surveying the positions of the fiducial fibres and the positions of stars on the sky, it effectively ties the fiducial coordinate system to positions of objects on the sky.

The most basic approach to correctly positioning a fibre would be to use the FPI camera to measure the relative position of the object (e.g. a star) of interest, and the fiducial fibres on the plate. The plate would then be tumbled to the configure position, where the gripper could place the science fibre relative to the fiducial fibres. Then, the plate would be tumbled back to the sky, where the object's light would then focus onto the fibre.

It would be very time consuming to iterate this approach for every one of 2dF's 400 fibres, so instead a mapping of the sky coordinates onto the fiducial fibres is made in advance (the "poscheck"). This model mapping is then used to position the fibres accurately for various science fields. The actual poscheck measures the positions of 60–80 stars with accurate positions against the positions of the fiducial fibres using the FPI camera. These positions are then used to build a model describing the transformation between [RA, Dec] on the sky and the plate coordinates [x, y] in microns. The model is stored in **two calibration files** which specify the **linear transformation** between the predicted and actual x,y coordinate system, and the **distortion model**. There are two versions of these files, one for each field plate:

Plate	Linear transformation file	Distortion file
0	tdFlinear0.sds	tdFdistortion0.sds
1	tdFlinear1.sds	tdFdistortion1.sds

These files are used by the FPI control software, the configuration software, and the tweak process run by the 2dF control task. At the telescope, the current model files are kept at `~2dF/config`. These files are also copied to the AAO FTP site at 8:30 am every day:

`ftp://site-ftp.aao.gov.au/pub/local/2df/latest_config_files/`

The `configure` software then uses these files to determine the positions of the fibre buttons (in microns) to match the requested target list of the astronomer (in RA and DEC). `configure` then generates an `.sds` file with these plate positions which the robot reads to position the fibres. For this reason, `configure` must have the most recent model files to produce an astrometrically accurate `.sds` file. In the control room, `configure` automatically uses these files, but it must be reloaded if they change.

27.2 Calibration Star Fields

The **POSCHECK** produces the best results with a fairly dense field of ∼ 80 stars near the meridian and in the declination range 00 to -30 deg. Currently **UCAC-2 fields** are preferred for the poscheck and a set of fields spaced at hour intervals have already been prepared. These UCAC-2 fields, all located at 00<Dec<-20, have around 80-90 stars each which are proper motion corrected, magnitude selected and with a radial distribution enforced. You only need to select a good UCAC-2 calibration field near the meridian (HA=0).

The directory ∼ `2dF/config/UCAC2` contains the current best poscheck fields files for the **UCAC-2 Fields**. The file name format is `UCAC2_hhmm±ddmm.sds`. `.fld` files are also available. Each .sds file has just a single fiducial fibre (150) allocated to a bright UCAC-2 star near the edge of the plate, and a list of non-allocated 80-90 bright UCAC-2 stars which will be used for the automatic calibration.

Although we strongly recommend using the UCAC-2 fields for the **POSCHECK**, some old astrometric calibration fields are also available. These are described in Section 28.7.1.

27.3 POSCHECK Procedure

This section describes the **POSCHECK** procedure, including preparing the telescope and instrument, loading the appropriate fields, validating the fit, and copying the appropriate distortion files to the correct locations. The **POSCHECK** procedure is done while guiding the telescope on a star in the astrometric field. To complete this procedure, follow these steps:

1. **Create a poscheck directory:** with the month and year of the run in the config directory e.g. ~2dF/config/poscheck_jul11/.

   IMPORTANT: The directory is **NOT** ~2dF/configs/, please note the final **s**.

2. **Load and Configure a poscheck field:** In the Positioner Control window, load a UCAC-2 calibration field (.sds file) near the meridian (HA=0) from ~2dF/config/UCAC2/ (see Section 27.2). Configure the field, so we can guide during the process. This should place only a single guide fibre, 150. *Make sure to tweak!*

   NOTE: If guide fibre 150 is broken **you will need to create a new .sds file**, as described in Section 28.6.

3. **Tumble and slew to the field:** Click Tumble in the Positioner Control window, then Commence Slew and Track in the Telescope Control window.

4. **Check that the ADC is tracking.** If it is not, in the ADC Control window click on Slew to Tel Pos, and then on Set Tracking, see Section 10.6.

5. **Unpark the FPI gantry and do a plate fiducial survey:** from Control Options button on the right-hand side of the FPI Control window (see Fig 11.2 in the 2dF-AAOmega Manual Volume I: User Guide), select the Centre gantry - survey check option.

   This will take some time (~2 min), and you **cannot configure/survey** the configure plate during this time.

6. **Open the Object Selection Window:** Commands → Select Object (and poscheck) entry in the menu of the FPI Control window.

7. **Move the FPI camera to the guide star:** Choose Allocated under **Select Objects by Allocation**. The object list should show one entry, select it, and then click Goto RA/DEC. The FPI will translate to the position of the star.

8. **Centre the guide star:** Take image with the FPI camera. An exposure of 1–3 seconds is usually good for ~ 12th magnitude stars. Follow the instructions described in Section 11.3 to centre the star.

9. **Focus the telescope:** If you have not already done so, focus the telescope accurately on this star following the procedure described in Section 11.4.

10. **Start Guiding:** Move the FPI clear using Control Options→Move Clear. As we are NOT parking the FPI, the axis of the telescope is set to REF automatically, as this matches the FPI coordinates, and hence the guide star should not be visible in the guiding system. Ask the night assistant to change to the appropriate axis for the current plate (A for Plate 0, B for Plate 1). This will bring the star back onto the guide fibre. Start guiding on the relevant fibre.

    NOTE: As we are doing the poscheck while guiding with a single fibre, the guide star will frequently be occulted by the FPI. The guider should beep and freeze and then recover when the star is clear. Keep an eye on the system just in case.

11. **Set an appropriate FPI readout window and centroid box:** For the poscheck to proceed, it must be able to centroid the correct star at each position.

    (a) In the Object Selection window, switch to Unallocated Guide (for pos check), and then **select a star from the** list and Goto RA/DEC. Take an FPI image using the full 512 × 512 window and not only the standard 200 × 200 window.

    (b) Because of the APOFF difference between the FPI camera and the plate, stars will not appear centred in the FPI while guiding. **Identify which star is the one selected**. You may need to image several stars to determine the approximate position the stars appear in the FPI if it is a dense field.

    (c) **Draw a centroid box** around this region: `Shift + Left-drag`. Remember the FPI pixel scale is ∼ 0.3 arcsec/pixel. A reasonable size in typical seeing (1–2 arcsec) is 40–50 pixels. If you have a poorer initial calibration a larger size will be needed (since individual stars will come in at different places on the FPI). If you draw a particularly large centroiding box/window, it may be necessary to iterate the poscheck procedure. See Section 28.5 if this is a problem.

    (d) Try selecting a few other stars to ensure they fall within the centroiding box. Especially try stars at different places on the plate, i.e. at large positive/negative X, Y. **If other stars don't come very close to the centre of the centroiding box, you might have a plate rotation problem**. See Section 28.5 for an alternate poscheck procedure for this case.

12. **Update FPI Pixel mapping and scale:** Rarely, the FPI pixel scale and mapping may need to be re-calibrated. These two steps should only be undertaken by an expert who knows what they are doing (i.e. the instrument scientist). They are described in Section 28.4 on page 24.

13. Set the integration time of the FPI camera to 1−2 seconds. The saturation level is ∼65000 counts. In good seeing (< 1.3 arcsec) shorter exposures may be needed.

14. **Start the Automatic Calibration:** Click the POSCHECK button in the Select Object window. You will be prompted for the directory to save the fit results in. **Do not use the default directory (overwriting the system files!).** Use the same sub-directory that you created earlier (e.g. `~2dF/config/poscheck_jul11/`). The file names themselves (e.g. **tdFlinear0.sds**) should automatically come up correctly, but check to make sure.

    Error messages may come up if a centroid fails, usually because the star image is saturated. This is not a problem—the star will simply be marked as unusable and the calibration will continue. About 20 usable stars are needed for a good solution.

    NOTE: The Automatic poscheck should take about 5–10 minutes.

15. **Save the Raw Poscheck data:** When the poscheck is finished, a pop-up will appear asking you to enter a file name for the raw poscheck files to be written to the directory you chose before. We suggest something like `raw0.sds`/`raw1.sds` for plate 0/1. Save the files.

16. **Select Cut Level for distortion fit:** The dialog box for this step comes simultaneously with the step 15. The automatic poscheck program calls the `tdffit' to create the poscheck files (`tdFlinear0.sds`, `tdFdistortion0.sds`, etc). This program asks you to chose the cut level to clip outlying stars and refit the model (120μm tends to work well).

17. **Check the final RMS:** The final RMS is reported in the FPI Window's Messages area (above all the "Residual Vector" messages):

```
Fit pass 3 fitting to 88 points
Changing distortion x0/y0 to -1057.71, 2118.22
 Linear              Distortion          Linear-Decomp
 a =   1144.559    a =   1.34e+07   Xzero  =     1139.4 microns
 b =      1.000    b =   1.09e+09   YZero  =     -271.3 microns
 c =     -0.020    c =   6.21e+11   XScale  =      1.000
 d =   -248.404    d =   3.31e+14   YScale  =      1.000
 e =      0.020   x0 =  -1.06e+03   NonPerp =     -0.002 degrees
 f =    0.99972   y0 =   2.12e+03   Rotn    =     -1.149 degrees
Pass 3 fit RMS =      47.66   PSD =      49.38
```

   The final RMS reported should be in the range ∼40 – 50 microns (remember 1.0 arcsec is 70 microns).

18. **Copy the distortion files into the working (system) directory, ∼2dF/config/:**

```
cp tdFlinear0.sds ~2dF/config/tdFlinear0.sds
cp tdFdistortion0.sds ~2dF/config/tdFdistortion0.sds
```

   Confirm the overwriting.

19. **Repeat the procedure for the other plate:**. Note that you may have to change to another UCAC-2 field closer to the meridian if you have spent too much time with the first plate. In principle, it is possible to start configuring the calibrated plate while the second poscheck is underway. However, **DO NOT** try to unpark the FPI while the Gripper is performing a plate fiducial survey, because the fiducial illumination is controlled via the FPI PMAC, and an attempt to unpark it will crash 2dF, requiring a restart. Also keep in mind the following step.

20. **Reload `configure` to reload the new poscheck information:** Although `configure` on the telescope computers uses the working files at `~2dF/config`, it only reads them on start up. Therefore, it must be reloaded before creating `.sds` files for observing.

27.4 Creating New Poscheck Fields

Poscheck FLD files are similar to regular observing FLD files, and the formatting is identical. Generally, a poscheck field consists of stars with very accurately known positions (and proper motions). The field should contain all the targets as both regular targets, and as guide stars.

Experience has shown that a good poscheck FLD has:

- Approximately 80 stars
- The bulk of the stars should be clustered at 2/3rds the plate radius.
- Some stars should be repeated (by providing the coordinates for it twice under different names), particularly near the centre of the plate.
- The FPI should regularly visit stars on opposite sides of the field, and in an approximately random sequence. Stars are visited by the poscheck sequence in the reverse order they are listed in the file.

Chapter 28

Other 2dF Support Tasks

Described below are several extra 2dF first night calibrations which are not normally necessary, as they have not been observed to change with time. They should, however, be checked occasionally. Some troubleshooting procedures for various problems are also included.

28.1 Review/recall Survey and Poscheck Data and Plots

28.1.1 Survey Data

Each time the robot conducts a survey with either the gripper or FPI, the resulting data is written to a log file in the directory

```
/logs/aatinst/2dF_surveys
```

The plots can be re-generated from these survey files using the `survey_residuals` command on `aatlxy`:

```
> $TDFPOS_DEV/survey_residuals 2dF-Survey-plate-0-gripper-2010-11-25-030344.sds
```

28.1.2 Poscheck Data

Reviewing the poscheck data requires finding the data. Assuming that the poscheck data has been saved into the directory structure as described at § 27.3: POSCHECK Procedure, then it should be easy to find. Once found, the plots can be reviewed using the `survey_residuals` command on `aatlxy`:

```
> $TDFPOS_DEV/survey_residuals raw0.sds
```

Two poschecks can be compared using the plotdiff python script. This script is found in `/instsoft/2dF/config/poscheck_diff/`. To run the code, go to the aforementioned folder and type the following command.

```
> python plotdiff.py -a -1 /path/to/old/sdsraw.sds -2 /path/to/new/sdsraw.sds
```

An image will be shown comparing the two poschecks. This image will be saved in `/instsoft/2dF/config/poscheck_diff/` with the filename stating the two poschecks compared.

28.2 Check FPI and 2dF plates are confocal

If it is a Directors/Setup night, it is good practize to check the FPI and 2dF are confocal. To do this, focus the telescope normally as described in Section 11.4. You will also need at least one guide fibre either configured at the centre or on a star. This test can also be undertaken on the first science field of the night, after the poschecks, so long as the telescope is near the zenith. In many respects this is better as one can check the plate focus using all 8 guide stars. Also, one should really do both field plates.

Drive the FPI clear and have the NA centre the star on the central guide fibre. The NA should then drive the telescope out of focus to evenly illuminate all seven guide fibres in the central guide bundle. Note this value down and then repeat at the other side of focus. The correct PLATE focus value is midway between these two values. In stable conditions this value should agree well with that measured from the FPI focus task. If not, report this serious fault. Continue with the poscheck procedure, using the FPI focus value, but once observing commences, use the PLATE focus value. The value is best derived using all 8 guide fibres on each field plate and the test should be repeated for each plate once an error has been found.

28.3 Re-reducing the poscheck calibration data

Occasionally, you may wish to rerun the fit of the poscheck data, e.g. to choose a different cutoff for star rejection or review the parameters of the fit.

If you think you need to rerun the program, `tdffitr` can be found in ~2dF/config. To run `tdffitr`, type the following:

```
~2dF/config/tdffitr raw0.sds 280 890 0.5 0.7
```

where the values correspond to Temperature(K), Pressure(hPa), Humidity, Wavelength (μm), respectively, and where `raw0.sds` is the raw data from the poscheck run, and the following four parameters are the temperature, pressure, and humidity (note that the humidity is given as a decimal!), and the mean wavelength seen by the FPI (this should always be set to 0.7). The program outputs new linear and distortion files called: `tdflinear.sds` and `tdfdistortion.sds`. It also outputs onto the screen a summary of the fit and lists the results for each star. The key things to note here are the "RMS" for each pass, and the number of stars fitted. Often 1-2 stars are rejected after the first pass, improving the fit RMS. If stars have been rejected, and the fit is improved, then the default files output earlier by `tdffit` (e.g. `tdFlinear0.sds`, `tdFdistortion0.sds`) should be replaced with the files output by `tdffitr`; e.g:

```
mv tdFlinear.sds tdFlinear0.sds
mv tdFdistortion.sds tdFdistortion0.sds
```

(confirm the overwriting). Or for Plate 1:

```
mv tdFlinear.sds tdFlinear1.sds
mv tdFdistortion.sds tdFdistortion1.sds
```

28.4 Update FPI pixel to gantry coordinate mapping and pixel scale

Experts Only! If the FPI has been recently remounted on 2dF (after maintenance or adjustment–unlikely), it will be necessary to calibrate the FPI plate scale. Do not attempt this step if you are not 100 percent sure what you are doing.

1. Centre a star in the FPI.

2. Redraw the centroid box to cover the full 200×200 window, and then select Commands → Calibrate Camera to Field Plate in the FPI Control Window. Watch the FPI image carefully as odd behaviour has been seen in the past (offset at 90 degrees to that which was expected).

3. Click on the Calibrate button in the pop-up.
4. The gantry will be moved to offset positions in each direction from the centre and a centroid taken at each one and the calibration determined. The resulting calibration file is automatically stored in the system. Take a final image at the end to make sure star is centred (final image is not taken automatically.)

It also may be necessary to re-calibrate the absolute plate scale (i.e. FPI pixels/arcsec). This is done similarly to the steps above, except select the Commands→Calibrate Tel/Camera... menu. The difference is that the telescope is offset between the positions rather than the gantry, again it is all handled automatically.

28.5 Poscheck after large change in plate rotation

If significant work has been done to the gantry, or if the plate rotation has changed significantly since the previous run, the stars may not fall inside the centroid box or even within the FPI readout window and the poscheck will fail. If you think that is the problem here this is what you need to do:

1. Follow the normal poscheck procedure outlined in Section 27.3 up to step 11.
2. Increase the size of the FPI CCD readout window using the Commands → Set Window menu option.
3. Select and view a few stars as in step 11 of the usual procedure.
4. Draw (via `shift + left-drag`) a box large enough to cover all the positions of the stars. Do this by drawing a box (`shift + left-mouse-drag`) around the entire IMG CCD frame (in the white part of the IMG window). Centroiding will then be done using the entire IMG window. Keep in mind that this will fail if multiple stars fall in the box, so if the field is particularly dense, a new field may need to be configured.
5. Complete the remaining steps of the poscheck as usual. The RMS should be reasonable (35–40). The poscheck will take longer than usual because it has to readout the entire FPI frame. You could optimize this by using a cut down field which only includes a few stars near the centre of the field to remove the gross error, and then a normal poscheck to refine the result.
6. Back up the system/working distortion files `tdFlinear*.sds` and `tdFdistortion*.sds` files in `~2dF/config` by copying them e.g. to your home directory.
7. Now copy the appropriate `tdFlinear*.sds` and `tdFdistortion*.sds` files into the active/system directory at `~2dF/config`. This is so the next poscheck you do (see below) will use these files as the starting point.
8. Choose Commands → Set Transform Parameters in the FPI window to pick up the new poscheck information.
9. Now you should repeat the entire poscheck per the normal procedure. At step 11, a reasonably small centroiding box should be sufficient, and various stars should all land close to the centre of the box. If not, then the first poscheck has not found a reasonable fit! You should start over: copy the backup you made of the existing distortion files back into the system directory, reload them, and start again (consider a different field).
10. If the second poscheck completes successful with a reasonable RMS (30–45), you are done. Carry on with other poschecks as required. If not, *get expert help!*: rerun the fit as described in 28.3, try different cuts, iterate again with the poscheck.

28.6 Poscheck .sds uses a broken guide fibre

Very rarely the usual guide fibre (150) is broken and cannot be used for guiding during the poscheck. In this case, use `configure` to create an alternate `.sds` file as described below:

1. Copy the `.fld` file to a working poscheck directory (e.g., ~2dF/config/poscheck_jul11).
2. Run `configure` from the terminal as usual (e.g. on `aatlxa`) and open the `.fld` file. The choice of plate is unimportant here.
3. Enable Expert mode by choosing the Options→ Expert Mode menu item. This allows you to save the special `.sds` file to be created.
4. In the plate image window, click on a green guide fibre, preferably 50 or 100 if 150 is unavailable (these guide fibres are obscured the least by the FPI gantry as it patrols the field), and then a guide star nearby (marked by a box, not the inner circle).
5. From the menu in the main configure window, choose Commands→Allocate fibre. Then save the `.sds` file.
6. Copy the new `.sds` file to your working directory (e.g., ~2dF/config/poscheck_jul11) and continue as normal.

28.7 Poschecks when plate rotation is unavailable

First, get expert help if you haven't already!

2dF has a Declination dependent field plate rotation due to a combination of the intrinsic geometric rotation of the sky and plate flexure. If plate rotation is unavailable, then this rotation can be compensated for by executing a poscheck near in declination (within $\sim 10°$) to the science field. Those distortion files are then used to configure the science field.

Organise the files by creating sub-directories in the usual poscheck directory, e.g.,

~2dF/config/poscheck_jul98/ ,

for each declination that has been measured, e.g.,

~2dF/config/poscheck_jul98/m5/ and ~2dF/config/poscheck_jul98/m30/ ,

for $\delta = -5°, -30°$, respectively, etc. The files have the same name as in the top level directory (i.e. `tdFlinear0.sds` etc.) and can easily be copied back to the top level before setting up a field. For example:

`cp ~2dF/config/poschecks_jul98/m30/* ~2dF/config .`

Keep in mind that `configure` only reads the distortion files on start up, so you will need to make sure you re-start `configure` with the correct files before configuring any science field. You can change the default location `configure` picks up its files by setting the environment variable `CONFIG_FILES` before starting `configure`, e.g.:

```
setenv CONFIG_FILES ~2dF/config/poscheck_jul98/m30
configure -p n &
Opening distortion file /instsoft/2dF/config/poscheck_jul98/m30/tdFdistortion0.sds
Opening linear file /instsoft/2dF/config/poscheck_jul98/m30/tdFlinear0.sds
Reading /instsoft/2dF/positioner/tdFconstants.sds
...
```

28.7.1 Additional sources of astrometric fields

It is non-trivial to find high density astrometric calibration fields across the whole sky. Although we strongly recommend using the **UCAC-2 fields** described in Section 27.2, files with astrometric calibration fields have also been prepared from the Tycho-2 catalogue, Positions and Proper Motions catalogue (PPM), Astrographic Tycho Catalogue (ACT), and Sloan Digital Sky Survey (SDSS). These can be found in the /Tycho2, /PPM, /ACT, /SDSS (respectively) subdirectories of ~2dF/config/. Due to an oversight in their file format, these can only be viewed using `veryoldconfigure`.

Keep in mind that to be accurate, **the fields should have accurate and current corrections for proper motions**. The positions of all calibration fields below are (at best) corrected to epoch 1998 and should be updated for proper motions before use. As the old configuration files do not include the actual proper motions they cannot be updated, but new input poscheck fields have to be created. That is done going back to the original catalogues to extract the original positions and proper motions, and then deriving correct positions for equinox 2000 and epoch 2012. Of course, that is not something anyone should try in the middle of the night.

Hence, **these old configure files are now useless**, but we keep this information here because it may be valuable to the support astronomer.

Tycho-2 Fields Directory ~2dF/config/Tycho2. These consist of stars taken from the Tycho-2 catalogue. We have Tycho-2 fields for declinations of −5, −30, −50, and − 70 deg (with a few exceptions) every 2 hours in RA (0, 2, 4, ... 20, 22 hours). The files are named according to position– e.g. `t2_f12m30r.sds` is at RA=12 hours, and DEC −30 deg. They typically contain 30–40 stars per field (repeated twice as Program Objects and Fiducial Stars). About half of the `.sds` files in this directory are in a 'ring' format, i.e. distributed around the periphery of the field with a few (3) central repeats. This is to optimise the definition of the distortion map centre. These 'ring' files should be used whenever possible, and they have names like `t2_f12m30r.sds`. Sometimes there were too few stars to give a good ring distribution, in which case the full field sample was used and then intermediate radius stars were eliminated to give a total of ∼ 40 stars. These files do not have the suffix 'r' in the name, e.g. `t2_f16m05.sds`. In a few cases there are simply not enough Tycho-2 stars within the field, and no poscheck file at all could be created, e.g. RA = 6 hours, DEC = −50 deg.

PPM fields Directory ~2dF/config/PPM(at the time of writing, this is linked to ~2dF/config/PPM2000; i.e., the positions have been proper-motion corrected to 2000). These consist of stars taken from the southern Positions and Proper Motions catalogue ($V \sim 7$–10) which have typical position accuracies of about 0.1 arc sec in each axis. The field centres are distributed all over the sky for Declinations $-90° < \delta < -5°$. They typically contain about 20–30 stars.

ACT fields Directory ~2dF/config/ACT/. These consist of stars taken from the Astrographic Tycho Catalogue ($V \sim 7$–12) and cover $-90° < \delta < +30°$. Each field has about 2–3 times as many stars as the PPM fields and positions are slightly better. They can be used as photometric calibrations (i.e. by configuring fibres and taking spectra) as they have accurate B and V-band CCD photometry. They typically contain about 30–80 stars (repeated twice as Program Objects and Fiducial Stars).

SDSS fields Directory ~2dF/config/SDSS/. These consist of stars taken from the astrometric calibration fields defined for the Sloan Digital Sky Survey. They cover only a great circle around the equator ($\delta = 0°$). They can be used for equatorial astrometric calibrations or as photometric calibrations as they have accurate R-band CCD photometry (see ~2dF/config/SDSS/README). There are two sets — the first set of files (`sdss*`) contain typically 100 Fiducial Stars ($R < 13$) and 400 Program Objects ($R < 15$). Generally this is too large for most purposes (e.g. POSCHECKs) so there is a second set of randomly stripped files (`smallsdss*`) containing typically 50 Fiducial Stars ($R < 13$) and 50 Program Objects ($R < 15$).

If you need to create your own poscheck field, it is similar to preparing any other field for 2dF. The poscheck procedure requires a `.sds` file. These can be created from an ASCII `.fld` file using the current version of `configure`. The `.sds` file should include a single guide fibre allocation, preferably one of fibre numbers 50, 100, or 150, as they are obscured the least during the poscheck. The procedure in Section 28.6 will be helpful for anyone wishing to create their own poscheck field files.

Chapter 29

AAOmega Support Tasks

29.1 Changing the gratings or dichroic in AAOmega

This section should be undertaken by instrument scientists only!
Get one on the phone before proceeding.

Changing the gratings in AAOmega is simple, but the gratings and dichroic are heavy and fragile and are in a confined space close to precision optics. Grating changes should only be undertaken by experienced AAO staff. If at any time you are unsure of any aspect of the procedure, contact the afternoon technician or the instrument scientist. The necessary procedure is below. The AAOmega grating set is compiled in Table 3.1 and described in Section **??**.

1. Figure 17.1 shows a top-down view of the AAOmega spectrograph. The door to the coude west room (on the 4th floor) is at the bottom right of this image. As noted in the caption, the spectrograph is shown with the Red camera in high dispersion mode, the Blue in low dispersion mode. Note the restricted access to the blue grating.

2. First, look at the spectrograph and decide if the camera must be moved to allow you to access to the gratings. If the cameras are to be moved use the control task in the control room (ensuring that the camera tracks are free from any obstructions.)

3. Close the dark slides to the two cameras. This protects the dewar aspheric windows.

4. The gratings and dichroics each have aluminium rectangular box covers (stored in the coude room cupboard). The correct covers for each element are a close fit. Each cover has a slot cut in the top so that the handle of the element fits through. Ideally these covers should be fitted before attempting to replace either the gratings or the dichroic but in certain instrument configurations fitting these covers may be more risky to the optics than carefully removing the grating first.

5. You will most likely need to stand on the AAOmega bench to move the elements.

6. The grating mounts are located in kinematic seats on the two grating turntables. Each grating is locked into position by **three CAPTIVE bolts** which should be **FINGER TIGHT**. **DO NOT use** an allen key to undo or tighten these bolts. Undo each bolt by hand until it turns freely, gently lift the bolt, it will not come free of the mount completely.

Figure 29.1: *Physical layout of AAOmega.*

It shows the red camera in high dispersion mode and the blue camera in low dispersion mode.

7. With all three bolts free, position yourself above the grating and take hold of the handle on top of the grating mount. The grating mount is heavy and must come straight up-and-out of the spectrograph without being allowed to touch any other parts.

8. Lift the grating, smoothly, straight up from its mounting position, and clear of the surrounding optics. The mount should come away from the turntable easily, once the weight is taken up, and so if there is any resistance stop and confirm that all of the **CAPTIVE** bolts are correctly freed.

9. Cover the grating with its protective aluminium cover and store it in the Coude room cupboard. Locate the new grating, remove its cover and repeat the grating extraction process in reverse.

   NOTE that the correct alignment of the new grating with the turntable is indicated by a white mark on the grating mount and the turntable. The three balls in the turntable based will align with the three grooves in the grating mount.

10. Carefully tighten the three bolts **BY HAND**. **DO NOT use** an allen key.

11. Open the dewar dark slides.

12. In the control room check that the new gratings and dichroic has been detected and set the central wavelengths for the next observations. The current grating/dichroic are listed in the AAOmega Full Status Dialog window (see Fig. **??**). To change the central wavelengths click the Configuration button in the Spectrograph Control Dialog window (see Fig. **??**) and select Set Blue/Red Arm Wavelength. Enter the new Centre and Blaze Wavelengths and click OK. If it finds it difficult to find your new wavelength, click the Home First option and try again.

13. Remember that, with the low resolution blue data, you need to take a flat and arc and reduce then to check that the λ5577 skyline does not fall on bad pixels.

29.2 Old AAOmega Focus Procedure

NOTE:
Originally, AAOmega was focused using an IRAF task. Although the relevant algorithms have now been incorporated into the control task, occasionally it is necessary to focus the spectrograph manually (e.g., because of a hardware failure), as described here.

The AAOmega focus procedure uses pairs of Hartmann shutter arc frames to derive the focus offsets for the current grating setup. The principle of the focus technique is to measure these shift as a function of position on the CCD, and then adjust the detector position (Spatial and Spectral tilts plus a Piston out of the plane of the tilt) to minimize the observed shifts.

The analysis of the Hartmann data pairs is currently performed using an IRAF script. The script takes as input a Left+Right Hartmann pair, smoothes the images to reduce the impact of bad pixels, cross-correlates 9 subregions of the images, in a 3×3 grid, to determines shifts, and then returns suggested values to adjust the focus.

We recommend focussing the spectrograph every night, a few hours before observing starts (with the dome lights off). A detailed explanation of the AAOmega focus procedure can be found in the internet address `http://www.aao.gov.au/AAO/2df/aaomega/aaomega_focus.html`. Here we just include the most important steps to follow.

1. Login to **an user account** (typically YOUR account!) on `aatlxa` and change to a convenient IRAF directory and run`xgterm`.
2. Start IRAF and define the hartmann task if you do not have it already included in your `iraf.cl` file.

   ```
   > setenv FOCUSHOME /instsoft/2dF/config/aaomegafocus
   > cl
   IRAF>task hartmann = /instsoft/2dF/config/aaomegafocus/hartmann.cl
   ```
3. Using the `tdfct` control task (AAOmega Spectrograph Control Dialog window → Calibrate AAOmega Blue Arm), **close the Hartmann shutter A**. This is the left-hand shutter as indicated by the `tdfct` mimic. **The order IS important for the Hartmann task**.
4. **Take a standard arc frame** for your current grating setup. Using the AAOmega CCD Control window is explained in Section **??**. This frame can be taken in **Ultra-Fast mode**, and can be taken as **dummy data**. Remember that for high resolution gratings you may need exposures of even 10 minutes to get a good S/N. Check the counts to ensure the data are not saturated and bear in mind that half of the light is occluded by the Hartmann shutters. For low-resolution gratings exposure times of 60 seconds are usually fine. See Table 5.1 to get an estimation of arc exposure times.
5. Using the `tdfct` control task, **close the Hartmann shutter B** (the right-hand shutter as indicated by the `tdfct` mimic). **The order IS important for the Hartmann task**.
6. **Take another arc frame** using the same parameters (exposure time, UltraFast mode, and Dummy data mode) you did before.
7. In the `aatlxa` IRAF terminal, **copy the relevant files to the working directory**. Data are stored at:

   `/net/aatlxy/data/aatobs/OptDet_dummy/yymmdd/ccd_1/`

   and

   `/net/aatlxy/data/aatobs/OptDet_dummy/yymmdd/ccd_2/`

   Note, both arms of the system may be focused at once, but if dummy data is taken, the file names will be identical, so please take care.
8. **Run the hartmann task** at the IRAF prompt:

   ```
   IRAF> hartmann A B
   ```
9. Once the task has finished, **check the last three lines**. These will give you the detector Spatial (**Spat**) and Spectral (**Spec**) tilts, and the focus Piston (**Pist**) offset.
10. Now **apply the focus offsets to each camera** in turn using the Calibrate Blue/Red arm options in the AAOmega control task. Apply these values to the **Absolute values** of the current detector focus in a single step.
11. **Repeat the Hartmann test with the new settings until the focus values have converged**. This is known when the last line written by the Hartmann task says `FOCUS OK`. Usually, around 3-4 iterations are needed to get a good solution.
12. Finally, do not forget to **open both Hartmann shutters**.

If 2dF is just back on the telescope the focus can be done with the fibres parked. If there is little/no light coming through then the focus might be very wrong. You can check the last focus value from data headers or the database (`http://www.aao.gov.au/archive/`).

29.3 2dF fibre positioning

29.3.1 How 2dF works?

The 2dF has two interchangeable field plates mounted back-to-back and two large XY gantries, the upper Gripper gantry which carries the robot that positions the magnetic buttons at the ends of the fibres and the FPI gantry which faces the primary mirror of the AAT and carries the FPI. Both gantries are fitted with CCTV camera that can look at back-illuminated fibres. The 2dF software converts the celestial coordinates (positions) of the targets and guide stars to XY coordinates in the focal plane, taking accounts of many known factors such as atmospheric refraction and optical distortion in the 2dF corrector lens.

Sets of astrometric standard stars are measured with the FPI and used to determine the transformations between the calculated star positions and the 2dF XY scales. This is known as the "poscheck" procedure and is carried out every time the 2dF is mounted at the top end of the telescope. The basic reference frame is provided by a set of 80 illuminated fiducial pinholes in each of the field plates (the coordinate system is thus different for the two plates). The positioner gantry measures the same fiducial pinholes after the tumbler has interchanged the two plates. Thereby completing the transformation between the input positions on the sky and robot coordinates. Each successive XY transformation is calculated by a linear least square fit, allowing for zero point shifts, rotation, skewness of axes and scale changes.

29.3.2 The 2dF positioner problem

The 2dF robot has an internal measuring accuracy of a few microns and is required to place fibres within 15μm of specified positions. However, observers found positions errors of 1$''$ or more (where 1$''\sim$67μm). Practically the robot is placing some fibres accurately but on wrong positions. The hardware, software and observing procedures together can help to reduce these errors. Fibres in some regions of the field were being systematically misplaced, resulting in an overall loss of observing efficiency of as much as 20-30% (Sharp et al. 2006, Simpson et al. 2016)

There are many sources of astrometric errors and many parameters needed to define the coordinate transformations. Some errors are insignificant in practice while others are not. Mechanical flexure effects are generally very small, which made it unnecessary to take many poschecks at different declinations at the start of each 2dF run. Unforeseen problems include the non-straightness of some gantry axes, making linear transformations inadequate, and spurious distortions of the coordinate system when some fiducial pinholes are occulted by fibres.

There are some astrometric problem remaining: *i*) unknown distortions in the Gripper + FPI gantries; *ii*) Non-calibration of flexure compensation (Note: Early tests showed flexure effects are very small.) and *iii*) Non-implementation of temperature based adjustments.

29.3.3 The Grid Survey: Mapping distortions of the Gripper/FPI gantries

The celestial RA-Dec reference frame has to be connected to the XY system of the 2dF positioner Gripper gantry, via the FPI gantry and fiducial reference points in each 2dF field plate. The process involves a succession of coordinate transformations, from stars → FPI gantry → plate fiducials → Gripper gantry → fibres. The process derives a relative distortion map between the FPI and Gripper gantries, assuming that any mismatches are due to the distortion of the gripper gantry. The relative distortion between the two gantries can be mapped by configuring the 2dF fibres in a rectangular grid pattern (~400 boxes with a fibre placed at the centre of as many boxes as possible) and measuring the positions of the back-illuminated fibres (surveying with both gantries). The *'configure'* software applies successive linear 6-parameter transformations at each stage. These are derived from the plate survey of fiducials done before every configuration. They should remove any errors due to translation, rotation, skewness, or scale changes arising in the field plates or gantries.

However, there are systematic non-linear effects which give rise to large-scale coherent positioning errors of $\sim 0.5''$ and sometimes exceeding the $1''$radius of the fibres. The positioning errors have to be added to the other errors, i.e., A&G limitations, ADC not cancelling atmospheric refraction perfectly, random positioning errors, and CVD input positions errors. When all of these errors add then total errors are $> 1''$. Most of these errors arise in the Gripper gantry and can be corrected using a look-up table from a differential distortion map. This technique assumes that any errors in the FPI gantry are small compared to the Gripper gantry. This can be checked by carrying a "Raster scans" of offset exposures on a configuration of bright stars. The centroid of each star can be derived from the relative strengths of the total signal in the offset exposures, giving a true measure of the end-to-end positioning accuracy of the 2dF.

Another method to map the distortions is to combine the data from a large number of "Poschecks" surveys done at the start of each 2dF run.

The Grid survey tests led to substantial gain in the precision with which the fibres are positioned in the past. We try to repeat the tests to improve the precision of the fibre positioning. A set of four fibre surveys is required. These all have to be done in a relatively short space of time. The survey takes a long time, particularly with the FPI. The background of the Grid survey tests is described in Cannon et al. 2008 in AAO Newsletter No. 113, Feb 2008, p26-31.

The process: A special fiber grid pattern is needed to derive the distortion map. However, for the purposes of checking the distortion (rather than deriving a new one), any fiber configuration can be used provided it has a good spread of coverage across the field plate. Briefly the process is as follows:

1. Park the telescope, *zenith* is best, and NOT at access park (prime focus).
2. Survey the field plate fiducials with the gripper
3. Survey the fiber positions with the gripper
4. Tumble
5. Survey the field plate fiducials with the FPI
6. Survey the field plate fibers with the FPI

In practice this is all a little more complex to actually implement (getting fibers back-illuminated correctly etc. is tricky).

In practice: Note that the FPI can be done first if required, as long as FPI and gripper survey pairs are done.

All these files should be saved to a standard location and with a date stamp in the name. Note, the *tdfeng* save options default to saving to the directory */instsoft/instuser/aatinst/*. There is a subdirectory here called newFPI_fibresurveys. Please create a new sub directory in this one with the relevant date information, suggestions are:
/instsoft/instuser/aatinst/newFPI_fibresurveys/20170321/Gripper_survey_P#_20170321.txt
/instsoft/instuser/aatinst/newFPI_fibresurveys/20170321/Fib_gripper_P#_20170321.txt
/instsoft/instuser/aatinst/newFPI_fibresurveys/20170321/FPI_survey_P#_20170321.txt
/instsoft/instuser/aatinst/newFPI_fibresurveys/20170321/Fib_FPI_P#_20170321.txt

1. Turn on the full *tdfeng* debug information output (click the bug icon on the *tdfeng* task bar).

2. Park the telescope, at *zenith* is best.
3. From *tdfeng*, clear the text in the text box (right-click →clear text)
4. Force a Gripper field plate fiducial survey (Plates→survey fiducials)
5. Save the survey text from the text box (right-click→save to file)
6. Survey the fiber positions (Fibers→survey fiber positions). A prompt appears asking for the file name to save the data to.
7. Tumble the field plate
8. **Now the tricky bit.** The FPI gantry cannot see the fibers and fiducials by default; we need to swap the fiber illumination over.
9. Select Fibers→Back illuminate guide fibers for the plate the FPI is to survey.
10. From the AAOmega/HERMES *tdfct* control change the observing slit to be the one for the field plate the FPI is to survey.
11. Put the back illumination into always on mode (Parameters→Set/Report task parameters→Gripper gantry task→ Backill_always=1)
12. Clear the text box again (*tdfeng* right-click→clear text)
13. Force an FPI field plate fiducial survey (Plates→survey fiducials)
14. Save the survey text from the text box, (right-click→save to file)
15. Survey the fiber positions, with the FPI (Fibers→survey fiber positions), a prompt appears asking for the file name to save the data to
16. Repeat for the other field plate
17. Repeat all sets with as many different fiber configurations as practical
18. Email the 2dF team with the location of the results files (*aaomega_instsci@aao.gov.au*)
19. The 2dF team will do a quantitative check by applying the existing distortion map to an input Gripper survey (or to an new distortion map). If there are significant systematic residuals we probably need a new distortion map. The output list then will be sent to Tony Farrell, to replace previous distortion map.

29.3.4 Raster Scan: Precision of 2dF positions

The ultimate test of the 2dF positioning accuracy is to configure a field of standard stars and determine the offsets of the fibers relative to the centroids of the star images. This is acquired by a set of 2dF 'raster scan' typically a series of short exposures in a 3×3 (or 5×5) rectangular grid pattern. Raster scans are set of exposures on bright stars (10-12 mag) with good astrometric conditions and acquiring as possible fibers across the whole 2dF field. Some centered on the target and others with the AAT offset by 1.5″ in RA and/or Dec. This gives a direct check on the positions of the 2dF fibers relative to their target stars, using only the FPI gantry and camera. The relative counts in each exposure are then used to determine the fiber offsets.

Other effects can be investigated using the same raster scan data. For example, substantial Chromatic Variation in Distortion (CVD) is predicted across the 2dF field, due to the corrector lens design. This means that while the light at all wavelengths coincides at the centre of the field and again at the edges, there are substantial radial shifts at intermediate radii.

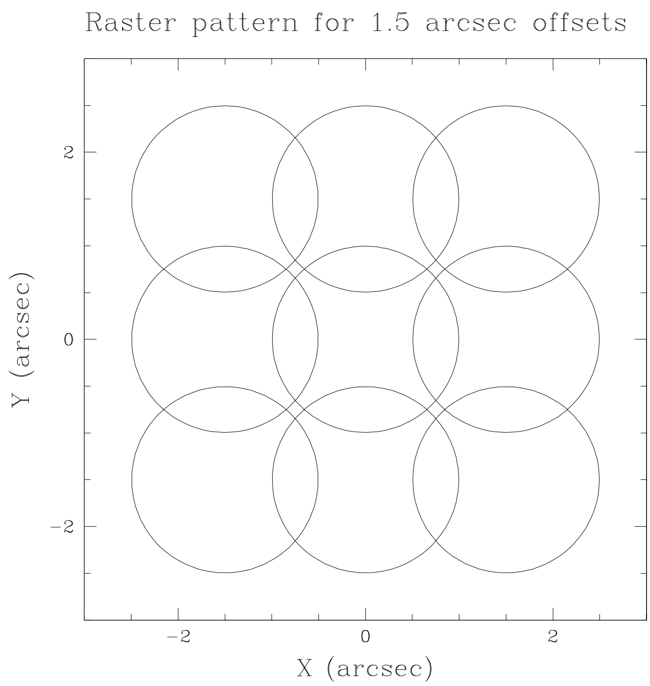

Figure 29.2: *3×3 Raster scan grid pattern for 1.5″ offsets.*

Table 29.1: *Raster scan standard scripts*

Menu entry	Script	Description
3×3 raster	3×3 raster	Implements a 3×3 telescope raster, taking observation at each point. The script prompts the user for the exposure time and telescope offset size. It does a total of 11 OBJECT observations of the specified exposure time. It does an initial observation frame at the center position, the 9 frames of the raster and an extra one at the center position.
5×5 raster	5×5 raster	As per 3×3, but implements a 5×5 raster, generating 27 frames.
Take Focus Frames	focus_data_acquire	Prompts the user for an exposure time, and then takes 2 arc exposures, with the appropriate lamps switched on for a standard Hartmann focus frame. The first exposure has Hartmann shutter 1 closed; the second has Hartmann shutter 2 closed. It then opens both Hartmann shutters. This script is used by the new automatic focus procedure available from the Spectrograph Control window

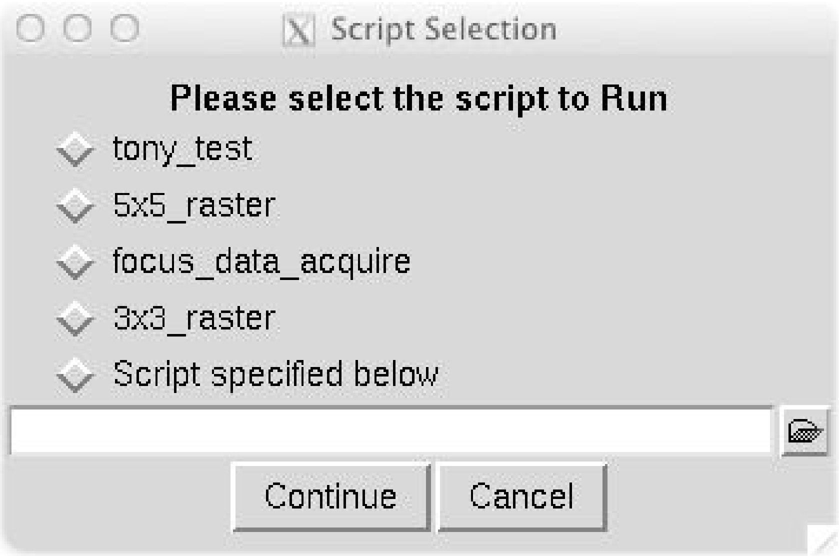

Figure 29.3: *The script file list dialog, listing the scripted operations.*

In Practice: The test should be done in clear conditions with seeing better than the mean seeing (1.5″). Use all 8-guide stars if possible, and retain 25 sky fibers. Configure the 2dF with the UCAC4 field and acquire the field as normal. Perform the 3×3 raster scan in square grid pattern with the following exposures (see Fig. 17.2):

- `start with a guided exposure at the center position`
- `take an unguided exposure at x=1.5,y=0`
- `take an unguided exposure at x=-1.5,y=0`
- `take a guided exposure at the center position`
- `take an unguided exposure at x=0,y=1.5`
- `take an unguided exposure at x=0,y=-1.5`
- `take a guided exposure at the center position`
- `take an unguided exposure at x=1.5,y=1.5`
- `take an unguided exposure at x=-1.5,y=1.5`
- `take a guided exposure at the center position`
- `take an unguided exposure at x=1.5,y=-1.5`
- `take an unguided exposure at x=-1.5,y=-1.5`
- `take a guided exposure at the center position`

The basic idea is to offset telescope in 1.5″ steps between each exposure and whenever going back to the center check the A&G. The careful interactions between the astronomer and the Night Assistant are required to keep track of the offset and exposures.

Analysis: The data were reduced using the 2dfdr and the median counts in each stellar spectrum were extracted. A 2D Gaussian with a fixed sigma of 1.5″ is fitted to the all observations of each star (i.e., the free parameters on the fit are the position of the Gaussian and its amplitude). The actual position of the star is found from the 2D Gaussian?s x and y position.

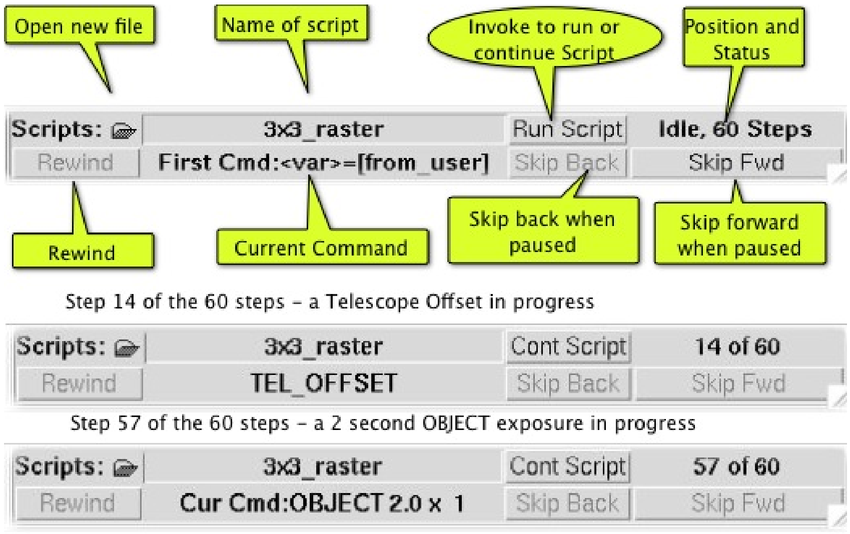

Figure 29.4: *Script control buttons and indicators. The first image is what you see on loading a script, then two examples show the status part way through a script.*

The results are then plotted showing a view of the plate with the initial positions of the stars as per fiber table and a vector indicating the direction of where the raster scan analysis says the star actually was. It should be noted that for fibers were the positioning in poor, the magnitude of the offset might be incorrect due to the fit being poorly constrained. It also assumes that the position of the telescope is as reported in the logs as in the MEANRA and MEANDEC in the FITS header are not precise enough to use.

Scripted Operations: The raster scans can be acquired through the 2dF control task scripts. These are available from the menu entry, Commands → Standard Obs Scripts (Fig. 17.3). Then select the script of interest from the sub-menu. It will start running immediately, but all these scripts prompt for user input or acknowledgment before running any command, which takes an exposure or moves the instruments or telescope. The standard scripts are provided in Table 17.1.

Fig. 17.4 explains the buttons of the script controls area. One particular thing to watch is that to run a script, you must invoke the Run Script button rather then the Start CCD Run button just above it. When the script is actually running, these buttons not active.

A script can be paused at various points. If doing a CCD observation, a "Pause Script" button is available. Any dialog produced by the script and the WAIT CONFIG command allow scripts to be paused. If you continue the script after pausing, the next command in the script will be invoked, unless you skip/rewind to another location. A script will also pause if an error occurs whilst running the script.

In rare cases, a script may stop due to an error without the script control buttons being made active again. If you can work out what is triggering this, please report it as a fault. To recover from such cases, invoke Commands → Unlock Script from the control task menu bar.

Part VII

Troubleshooting

Chapter 30

General 2dF troubleshooting

30.1 2dF Shutdown Fails to Complete Normally

The cause of an abnormal shutdown is normally a PMAC error from the tumbler if the positioner system was not tumbled back to the correct plate before shutdown. Very rarely, a power supply may not be shutdown correctly if another failure occurs first. For this reason, the user should check that both power supplies are shutdown before closing down the control task user interface.

If a problem occurs then the appropriate power supplies must be turned off before power cycling the hardware. **(NB Power cycling the hardware with the power supplies still active risks damaging the hardware and requiring a recalibration).**

- Enter the `2dFPos&` command in the `aatlxy` terminal window.
- From the console window which appears, click on the terminal window button to display a command prompt.
- Enter the `vmeIO` command (case sensitive) to start the vme test program.
- Enter the `aps off` command to shut down the power supply. A series of status messages should be displayed as the power supply is shutdown.
- Exit

30.2 Logging 2dF Information: "2dfsave"

There are times you need to log diagnostic information to trace a problem This can be done easily by typing `2dfsave` from the `aatssy` terminal window. This command brings up a "wizard" that asks you a few questions about what you were doing then. It then collects log files, robot status information, configuration files that were being configured, etc, and sends them all to Tony Farrell in an e-mail message. It is very useful in cases where something has gone wrong (e.g. a configuration has failed for obscure reasons; tdfct crash), and you need to save all the relevant information, so the problem can be reproduced later in simulation.

30.3 Positioner Initialisation Failure: NVRAM Problem

The occasional errors during the positioner initialisation are FPI or gripper gantry phasing problem, a power supply failure, the compressed air not being turned on, or a PMAC limit switch error messages. A possibility also includes occurrence of a Non volatile RAM (NVRAM) problem.

Here it is assumed that the failure has occurred when starting up the main 2dF system from `tdfeng`. You should wait for the complete initialisation of all the other tasks to finish with hopefully only the positioner in a failed state.

NVRAM error messages are displayed if the positioner parameter files on disk do not agree with the copy kept in NVRAM when the system was last shut down. The most likely cause is that the positioner was shut down in an abrupt manner so that the latest files did not get written to disk. To recover we need to overwrite the files with the most recent information in NVRAM:

- From the Gantry menu of `2dF Positioner` window, choose Reset. Check the relevant options and at the NVRAM Overwrite mode, click Overwrite files.
- Now choose the Reset item from the `commands` menu and the Recover option. You should see a warning message asking you to confirm the overwriting of the file data. If you are not sure at this point choose cancel and contact technical support staff, otherwise choose ok and the initialisation should continue in a normal manner.

Chapter 31

FPI troubleshooting

31.1 No light in the FPI?

- **Is it cloudy?** If not, the usual cause of target field acquisition problems are obscuration in the optical path, namely the next four points.
- **The primary mirror cover.** This is easy to check: just ask the Night Assistant.
- **The calibration lamp flaps**. To check the calibration lamp flaps, from the main Control Task (`tdfct`) window, click on calibration system. This window (see Fig **??**) shows a graphic which is red when the flaps are closed. From the same window it is possible to open the flaps.
- **The perspex protective cover over the corrector.** The corrector cover is unlikely to have been left in place if it is anything other than the first night of a 2dF run. Note that safe removal of the cover requires two staff working on ladders and should not be attempted alone without supervision.
- **The shutter built into the FPI camera.** It is possible to accidentally disable the shutter in the FPI camera. On startup the shutter control (just below the exposure time window) on the FPI control window is activated (yellow). Unfortunately it is possible to accidentally disable this (grey) and the FPI camera will not see the sky. If this is the case, then simply activate the shutter by clicking on it and it will turn yellow.
- **Is the CCD of the FPI camera working OK?** Rarely, you may have to reset it. If this is the case, check the Section 31.2.

31.2 Zero counts in the FPI camera

If there are 'zero' counts in the FPI camera image, then resetting the FPI will solve the issue. Choose the menu item Camera Task control → Control Options → Reset.

31.3 Restarting FPI without doing a full system reset

There are two approaches to fix the issue.

- **The image has zero counts**. This require the power cycle of the camera.
    1. Shutdown the FPI camera and its GUI only: From the FPI Camera GUI Interface select File → Exit and click "Yes". Both the GUI and the FPICAM camera task should shutdown and the related errors appear on the 2dF control task.

2. Then reboot the camera using the internet power switch web interface.
3. Wait for 30 seconds or more for the camera to reboot.
4. From the 2dF control task guide, execute Commands → Reset → Recover

- **The button greying out.** This may indicate that the camera task is hung and is not cleanly shutdown.

1. From the 2dF control task window, select Commands → Delete Tasks.
2. On the left of the dialog that pops up, select both `FPICTRL` and `FPICAM`.
3. On the right select: Just kill the task.
4. Invoke Do It. This will kill the tasks (equivalent of a "kill -9"). Since the 2dF control task knows this is happening you may not see any error messages come up.
5. Unclear if needed: Reboot the camera using the internet power switch web interface, followed by 30 second wait.
6. From the 2dF control task guide, execute Commands → Reset → Recover

31.4 Recovering FPI hung without restarting

When the FPI Control Task is stuck and keep indicating 'waiting', the procedures to bring FPI back rather than doing a full system restart are:

- From the 2dF control task guide, click Commands → Delete task → FPICAM → Just kill the task
- From the 2dF control task guide, execute Commands → Reset → Recover

Chapter 32

Plate Rotation Problems

32.0.1 Tumbling Prevented Because of Non-Zero Plate Rotation

This is a very rare problem. What happens is that 2dF doesn't allow the tumbling, because it thinks there is a non-zero rotation present on one of the plates. When 2dF tumbles, it is meant to rotate the current observing plate to zero rotation; sometimes this rotation is not exactly zero (but very close) and it will not tumble. The solution is simple: from the Engineering Interface select Parameters, Set/Report Task Parameters, and Plate Rotator Task. There you will see items "Plate0" and "Plate1". These should both be identically zero. If either isn't, double-left-click on it, and enter "0" in the box; then click "Done". Now try to tumble again, and it should work.

32.0.2 Uncontrolled Plate Rotation

We have had a few instances where one of the plates has undergone uncontrolled (and unwanted!) rotation. This can arise from several causes: something is loose in the plate rotation mechanism; the plate has become unclamped; or a faulty mechanism is driving plate rotation in an uncontrolled and random manner. The problem manifests itself when one attempts to acquire a field on the problem plate: the field cannot be acquired, because the field was setup using poschecks taken when the plate had a different rotation.

How to Diagnose Plate Rotation

There are a couple of other ways to see if the plates have been rotated, and these can be done in the afternoon. If you suspect for any reason that one or both plates have been rotated, try these:

- Try plate rotation on suspect plate (`Positioner window, Rotation`)
- Check the positions of fibres at different locations on the plate. First turn on the fibre back illumination (`tdfeng, Parameters→set/report task parameters→Gripper Gantry task`).To do this, select Fibres, then Check Fibre Positions from the 2dF Engineering Interface. Select groups of 10 fibres at the 4 quadrants of the plate, e.g. 100–110, 200–210, 300–310, and 390–400. If there has been no rotation, all of the fibres should come in at nearly the same place on the TV monitor. If there has been rotation, however, then each group of 10 fibres will come in at the same position, but each quadrant will show up at a different location: above, below, to the left, and to the right, which is the signature of rotation.
- Do either an FPI survey with the suspect plate in the observing position (from FPI window, select Control Options under Gantry Task Control, then Unpark, then Survey); or

a Gripper Survey with the plate in the configuring position (from Engineering Interface, select Plates, then Survey Fiducials). In either case, if there is rotation, you will see that the survey is ”struggling”, and the plate fiducials are a long way off from their expected positions.

How to Cure Plate Rotation

If there is uncontrolled plate rotation for any of the above reasons (or something else!), it will not be easy to fix. Most likely, the retractors will have to be taken off to find and fix the problem, and this will be a good day's work or more. If it is near the beginning of the run, there is probably no option though. For the case where the plate is stable during the night, a workaround is to take new poschecks on the offending plate at the beginning of the night, at the appropriate declination for the fiedls to be obserevd, and configure/reconfigure all fields on that plate. Poschecks can be done during twilight, and with practice can be done quickly and with little observing time lost; see the Troubleshooting Section in the 2dF Observing Guide for more details.

Chapter 33

Fibre positioning errors

33.1 Positioner Errors: Overview

Recovering from positioner errors requires considerable use of the 2dF positioner engineering interface and should not be attempted unless you feel confident in using this user interface. If necessary you can be talked through a recovery procedure by telephone.

Positioner errors can be broadly broken down into a number of classes, which are each discribed below. While it is unliekly that any indiviual error will match perfectly to any given recovery discription, the user should match the error the the closest section, and carefull follow the procedure outlines below. **If in doubt, bring the telescope down to access and examin the problem at each stage.**

After a positioner error, the control task will display a series of error messages, which are also repeated in the messages area of the Main Window with a red highlight. These messages should be pasted (select text, middle click to paste) into the fault report.

To enable easy recovery from positioner errors it is important to have a good understanding of the fibre positioning process. This is defined by the fibre pickup and putdown processes which are each divided into a series of easily understood steps. These are described below assuming that the back illumination is on in continuous mode for clarity; note that under normal conditions the back illumination is used in blink mode.

Steps to Pick Up a Fibre From the Fieldplate

- Long XY slew to position gantry above a fibre; fibre will appear out of focus if the back illumination is in continuous mode.
- Lower Z axis to pickup height, fibre will snap into focus.
- Centroid image to determine its exact location and check that it is present.
- Grasp fibre at exact location just determined. This may involve moving first the XY gantry to position the fixed jaw and then closing the moving jaw or alternatively moving the XY gantry and the moving jaw simultaneously.
- Raise the Z axis to lift the fibre from the fieldplate; the fibre should remain in focus indicating that it is retained in the gripper jaws.

Steps to Place a Fibre on the Fieldplate

1. Long XY slew to move the fibre to its nominal target position ('movetoplace'). The fibre should remain in focus.

2. Centroid the fibre image to determine its exact location in the gripper jaws (the pickup may not have been perfect) and confirm that nothing has happened to the fibre in transit.
3. Adjust the XY gantry position to allow for the exact fibre location in the gripper jaws.
4. Lower the Z axis to place the fibre on the fieldplate with a small amount of over-travel to ensure that the fibre is firmly pressed into the plate.
5. Release the fibre. This may consist of opening the moving jaw then backing off the fixed jaw by moving the XY gantry or alternatively opening the moving jaw and backing off the fixed jaw simultaneously.
6. Centroid the fibre image to determine its exact location on the fieldplate. Calculate its position error relative to the desired target position and compare with the allowed error tolerance (currently 20 microns or 0.3 arcsec).
7. If the position error is within tolerance then go to step 15.
8. If the position error is not within tolerance it will be necessary to iteratively adjust the fibre position to get it within tolerance.
9. The fibre is grasped (using one of the two methods described above) at the last measured position.
10. The Z axis is raised a small amount (currently 1.5mm above the field plate).
11. The XY position of the gantry is adjusted to remove the position error.
12. The Z axis is lowered to place the fibre on the field plate.
13. The fibre is released (again by one of the two methods described above) from the gripper jaws.
14. The fibre image is now centroided again and its position error determined. If the position error is still out of tolerance return to step 9 (a maximum of 10 iterations are performed).
15. Raise the Z axis clear of the fibre, the fibre image will go out of focus.

33.2 Fibre Tangles: Causes and Recovery

A fibre tangle may be noticed either as part of a recovery of the associated positioner problem (on inspection at PF access you realise that the centroid failure is a lot more serious and involves several fibres) or at startup of 2dF you notice fibres taking a distinctly bent or looped path between the retractor and the button.

This section is necessarily general, all fibre tangles are different and require extreme care when recovering. Please use your intelligence as one cannot give step-by-step instructions for every eventuality.

In general, it is better to move fibres with the gripper if possible, and only clear the minimum area. Please do not park fibres by hand unless absolutley neccessary, it is **NOT** quicker in the long run.

On noticing a tangle (and after recovering the immediate positioner problem if it is carrying a fibre) identify the problem fibre and use the *check fibre positions* utility to check 10-20 (or more) fibres either side of the suspected problem fibre. Note down any missing fibres.

First verify that the real life fieldplate looks similar to the engineering mimic. If the tangle is on the fieldplate, then use the gripper to park safe fibres (those with no crossovers or fibres which lie on top of other fibres (but check the engineering mimic agrees with real life)) one at a time to try and start clearing the troublesome area. Carry on as far as possible.

Once you can proceed no further with the gripper (or if the tangle is in the park position) it may be necessary to move some fibres manually. Any manually moved fibres must be noted down and must be left in the correct park position (don't replace them on the fieldplate) after any manual movement is finished.

If the tangle is in the park position it will be necessary to manually move fibres out onto the fieldplate, straighten out the tangle, then repark the fibres manually.

After all this you should have resolved the tangle and all fibres that have been moved manually should have been placed on the parkplate. Now for each manually moved fibre set its position to be 'parked'. ('fibres' menu, 'set fibre position').

Now do a 'check fibre position' for **at least** the range of fibres that you have moved, preferable larger since you may have moved something else accidentally.

33.3 Centroid Failures: Overview

A general note on centroid failures: the frame grabber will repeat the centroid and freeze the image on the tv gripper monitor in the control room, so even if the back illumination is in blink mode, it is possible that a frozen image will be visible permanently on the tv display.

A centroid failure can occur at any one of three points in the fibre placement cycle and it is important to identify the nature of the centroid failure as its recovery depends on the exact circumstances.

- The first possibility in the fibre placement sequence is that the positioner cannot see the fibre it wants to pick up. This is indicated by a **centroid failure during a pickup** operation. The Z axis will be left in a low position with the gripper jaws open. This is an unusual fault as it means that the fibre is not where it is supposed to be, a prism has been knocked off, a fibre broken, or even that the back illumination is not working for some reason.

- The next possibility in the fibre placement sequence is that the positioner fails to centroid the fibre when it is gripped in the jaws but after the fibre has been moved to its placement location (a centroid failure after the **move-to-place** step). This failure may be due to more than one cause. First, the pickup may have failed completely due to the gripper jaws not closing fully during the grasp and the button is still on the fieldplate at its original location. Second, the fibre may have been picked up, but again due to the gripper jaw not closing firmly enough during the grasp operation, the button may have tilted in the gripper jaws, thus moving the fibre out of focus. Other possible causes are a fibre breaking, or the prism falling off after the pickup stage.

- The last opportunity for a centroid failure is after the gripper jaws have opened and the position of the released fibre is measured. If the fibre jumps out of the centroiding window a failure will occur. The fibre may jump abnormally due to an obstruction on the fieldplate (debris or another fibre), or most likely when parking a fibre occasionally the fibre sticks slightly in the retractor causing the fibre not to behave as expected. Other causes may be that the fibre breaks at this late stage or a prism is knocked off.

33.3.1 Centroid Failure During Pickup

The cause of a centroid failure **during pickup** may be quite serious but it is usually simple to diagnose and recover.

First, examine the gripper tv monitor and see if a fibre is visible in the display: it may be that a fibre is visible but not in the normal small centroid window due to the fibre having been slightly dislodged on the fieldplate.

Fibre Visible in the Gripper TV Monitor

If you can see a single fibre in the gripper tv monitor, then recovery should be simple with no manual intervention required. Follow these steps:

- First check that the visible fibre is not an adjacent fibre by zooming in the engineering mimic and checking that there are no other fibres in close proximity (a few mm).
- Assuming that the fibre is in isolation, then it is likely that the off-centre image visible in the gripper tv monitor is the lost fibre. Start the gripper tv grabbing images again (*grab* item from the *camera* menu) and the image should disappear if the back illumination is in blink mode (note: guide fibres are permanently illuminated).
- Raise the Z axis to 7000 microns: *move axis* item from the *gantry* menu.
- Search for the fibre either at the current gantry position, or search for the fibre explicitly by giving its number (*cur* button or *fib* button respectively).
- Once the gripper has located the fibre, it will report the position in blue text on the engineering interface. The first two lines contain the fibre position (xf,yf).
- If you performed a *search at button position* then a pop up dailog will prompt you to update the fibre position. If you performed a *search at the current positions*, update the position of the fibre using the *set fibre position* item from the *fibres* menu: you will need to carefully enter the x,y position by hand, and enter a **return** after each x or y so that the theta position will update automatically.
- It is now advisable to check the locations of about 5 fibres either side of the troublesome fibre. From the *fibres* menu choose the *check fibre positions* item. Select the fibre range (remember to hit return) and click on *continue*. The gripper unit will centroid each fibre in turn and put the results in a dialogue box. Check the results for any fibres not found.
- Now that the fibre position has been updated it should be possible to recommence the fibre setup without problems

Fibre Not Visible in the Gripper TV Monitor

If the fibre is not visible in the gripper tv or if there is a possibility of a second fibre being in the field of view, more care in the recovery is required.

To inspect the cause of the failure, it will be necessary to either wait for the completion of the current exposure or re-time/abort the current exposure and fix the problem before continuing. The choice will depend on the relative priorities of getting the next field ready and getting data on the current field. Once the exposure is finished or aborted, slew the telescope to prime focus access for visual inspection of the positioner.

The gripper jaws should be low down hovering over a button handle. It should be obvious if the button is misplaced or the prism is missing. A less likely problem is that the wrong set of fibres are being back illuminated or that there is a fault with the back illumination.

The three broad categories of recovery are described below :

A: If the Button is Slightly Misplaced
B: If the Button is Severely Misplaced or the Prism has Fallen Off
C: Button Not Out of Position and Prism Intact

A: If the Button is Slightly Misplaced

If the button is just slightly misplaced (5mm) and there are no other fibres in close proximity, then the recovery procedure should follow the steps defined above (section 33.3.1) as if the fibre is visible.

B: If the Button is Severely Misplaced or the Prism has Fallen Off

- First move the gripper gantry out of the way (after making sure that you know which fibre is the problem). From the engineering interface, choose the *Move Axis* item from the *Gantry* menu. Raise the Z axis to a position of 7000 and visually inspect that it has done so. Next from the *Gantry* menu choose the *Move Clear* item which will move the gripper clear of the fieldplate.
- Now it will be necessary to manually park the fibre with a pair of pliers very carefully placing the fibre in the correct location on the retractor parkplate.
- Now set the current position of the fibre to be parked by using the *Set Fibre Position* from the *Fibres* menu in the engineering interface.
- If the fibre is damaged or the prism missing it will be necessary to disable the fibre: *Set/Report Fibre Details* from the *Fibres* menu). Clear the moving flag if needed.
- If the fibre remains in use but has been manually parked, then it is a good idea to search for the fibre (*Plates* menu, *Search* item) and update the actual position of the fibre so that a subsequent fibre pickup does not hit the button handle. Once this step is done it will be necessary to reset the *parked* flag for the fibre afterwards so that the software still thinks the fibre is parked.

C: Button Not Out of Position and Prism Intact

If the button does not seem to be out of position and the prism is intact, the back illumination should be checked by turning it on in continuous mode. The back illumination of all the fibres should be seen visually **(NB the gripper gantry must NOT be parked for this test: parking the gantry turns off the back illumination!)**. If this is not the case, expert assistance will probably be required. If the back illumination is visible, then raise the Z axis clear of the button (*Move Axis* from the *Gantry* menu on the engineering interface, moving the Z axis to a position of 7000). Then search for the fibre by choosing the *Search* item from the *Plates* menu. If you fail to locate the fibre quickly, then expert intervention may be required.

33.3.2 Centroid Failure with Fibre in Jaws

This error can be caused by a number of problems, for instance, a broken fibre, or a fibre button tilted in the jaws taking the fibre image out of focus. Since the gripper gantry is at the destination position when it fails, the current position is safe to place the fibre on the fieldplate, but the fibre details will be wrong.

Fibre Image Visible in Gripper TV Monitor

If a faint, in-focus fibre image is visible in the gripper tv image, then it is certain that the fibre handle is held in the gripper jaws with the fibre suspended above the fieldplate in a precarious situation. Note that the image may be very faint but the first few steps of the recovery procedure should confirm the presence of the fibre image.

This situation should be recoverable with care by following the following steps. Note that if a CCD exposure is underway, then the back illumination should be kept permanently on for as short a time as possible (or wait until the exposure is finished or aborted). If the recovery fails to proceed as described, then exercise caution and visually inspect at prime focus access to confirm the situation.

- Force the camera to grab images continuously using the *Camera* menu and select the *Grab* item. The image on the tv monitor should vanish (if the back illumination was in blink mode).

- Turn on the back illumination in continuous mode. (*Parameters* menu, choose the *Set/Report Parameters* item for the `gripper` task. Double click on the *backillum_always* parameter and change its value to 1. The in focus image should reappear, confirming the diagnosis of the situation.

- Determine if the gripper was putting a fibre down on the **field plate** or **park plate** (*i.e.* parking a fibre). A careful review of the error messages will reveal this.

- The gripper is at the carrying height (7000 microns), so it is necessary to lower the Z axis to place the button on the field plate safely. This is done in several steps to allow the process of lowering the Z axis to nudge the tilted button gently and straighten it up.

  – If the gripper was in the process of **parking a fibre**, then the final putdown height is 950 microns. Lower the Z axis first to 1100 microns (*Move Axis* item from the *Gantry* menu), then to 1000 microns, and finally to 950 microns.

  – If the gripper was in the process of **placing a fibre on the fieldplate**, the final putdown height is 450 microns. Lower the Z axis first to 1000 microns (*Move Axis* item from the *Gantry* menu) then to 900 microns and finally to 450 microns in 150 micron steps.

  The fibre image should be seen to shift sharply as the button makes contact with the fieldplate and return to a sharp focus. If this does not occur, then visual inspection is necessary.

- Now the fibre button should be firmly on the fieldplate, but still grasped in the gripper jaws. Open the gripper jaws by using the *Move Axis* command again, but now selecting the *Jaw Axis* and moving to an opening distance of 900 microns (the normal jaws open distance). As you click on the *Continue* button, watch (or get someone else to watch) the gripper tv monitor and you should see the image of the fibre give a very small jolt as the gripper jaw releases the fibre.

- Now raise the Z axis to the normal carrying height of 7000 microns using the *Move Axis* command **(NB: make sure you select the Z axis again after using the jaw axis**

last time). The fibre image should go out of focus but still be visible, which is a useful confirmation that the fibre button is now safely on the fieldplate.

- Now return the back illumination to blink mode, and the out-of-focus image should disappear if the fibre is a spectroscopic fibre, and **not** disappear if it is a guide fibre.
- The fibre is now safely on the fieldplate, but its fibre details are not up-to-date. The positioner system also still thinks it is carrying a fibre button, and will not allow a search for a fibre (or any other action) until it is told that it is no longer carrying a fibre. First the positioner and gripper tasks must be put into unprotected mode to allow you to change an important parameter. From the *Parameters* menu choose the *Set privileges* item and click on the *Gripper* and *Positioner* tasks before clicking on the *Continue* button. It should now be possible from the *Parameters* menu to choose the *Set Parameters* item for the *Gripper* task and check the *carrying_button* parameter. This will be set to *yes*. Double click on the *carrying_button* parameter and change it to *no*. The positioner task will no longer protest that it is carrying a fibre button.
- Using the *Search* item in the *Plates* menu (or the *torch* symbol on the *toolbar*) search for the fibre: click on *fibre*; select the right fibre at the top; then click *cur*; then *use button focus height*; then click *continue*. The gripper will be moved to a height of about 37,000 microns and a spiral search performed, starting at the current position. Once located, the fibre image will be centred and the exact position in microns displayed in blue text on the engineering interface.
- The first two lines of the blue text (xf,yf) are the fibre position. Subsequent lines contain the distances of the located fibre to the nearest known fibre positions: these should be checked if there is a suspicion that the wrong fibre has been located.
- Assuming that the correct fibre has been located, it is now necessary to update its position using the *Set Fibre Position* item from the *Fibres* menu. Select the correct plate (normally the default is correct) and the *to position* button, then enter the x,y position of the fibre located in the search (xf, yf from the previous step); if you hit return after each coordinate is entered the value of theta will be updated automatically **(NB: do not enter zero!)**. As you click on the *Continue* button, the fibre will be redrawn to the updated position which should be coincident with the gripper.
- Now the software knows where the fibre is located, but it has not had its crossover information updated: **continuing a setup now would result in a horrible fibre tangle**. The safest way to proceed is to park the fibre (this is safe as it was the last fibre to be moved and is therefore on top of any other fibre). Do this by selecting the *Parkfibre* item from the *Fibres* menu and set a fibre range to include just the fibre you have recovered (remember to hit return after entering the fibre number).
- Once the fibre has been safely parked, you may simply restart the fibre configuration (**assuming the telescope is not at prime focus access**).

No Fibre Image Visible in Gripper TV Monitor

If no fibre image is visible in the gripper tv monitor, then the telescope should be brought down to prime focus access for visual inspection. Possible causes are that the fibre is tilted so far that the out-of-focus image is not visible, the fibre could be broken, or the gripper jaws could be empty (with the fibre still at its original location).

On inspection, the gripper should be hovering over the fieldplate with the gripper jaws closed on a button handle. If the gripper jaws are empty, then it is most likely that the gripper has failed to pick up the fibre button; otherwise it should be obvious if the button is severely tilted or the fibre broken (usually just behind the button).

The three broad categories of recovery are described below :

A: If the Gripper Jaws are Empty
B: Fibre Held in Jaws but Broken
C: Fibre Held in Jaws but Severely Tilted

A: If the Gripper Jaws are Empty

If the gripper jaws are empty, then recovery should be simple. Follow these steps:

- Check the original location of the fibre that is supposed to be in the gripper jaws: it will be necessary to identify it on the engineering interface and then locate it at prime focus access.
- If the gripper simply failed to pick up the fibre, it will still be located on the fieldplate at the location given by the engineering interface, and the fibre details will still all be correct.
- If the above statement is true, then the positioner system also still thinks it is carrying a fibre button and will not allow any other action until it is told that it is no longer carrying a fibre. First the positioner and gripper tasks must be put into unprotected mode to allow you to change an important parameter. From the *Parameters* menu choose the *Set Task Operation Mode* item and click on the *Gripper* and *Positioner* tasks before clicking on the *Continue* button. It should now be possible from the *Parameters* menu to choose the *Set Parameters* item for the *Gripper* task and check the *carrying_button* parameter. This will be set to *yes*. Double click on the *carrying_button* parameter and change it to *no*. The positioner task will no longer protest that it is carrying a fibre button.
- Now park the gripper gantry (*Gantry*' menu, *Park Gantry* item) then unpark the gripper gantry; this will reset all of the gripper coordinate systems, which is the most likely cause of the problem.
- The last stage is to reset the flag that tells the software that the fibre is *moving*. From the *Fibres* menu choose the *Set/Report Fibre Details* item. Select the correct fibre and plate on this large dialogue box and press the *get details* button. The current details for the fibre should now be shown with the *moving* flag glowing in yellow. Click on the *moving* flag (it should go grey) and then click on the *Set Fibre Details* button.
- It is a good idea to check the location of the dodgy fibre and a few (~10) on either side: from the *Fibres* menu, choose the *check fibre positions* item. Select the fibre range (remember to hit return), and click on *continue*. The gripper unit will centroid each fibre in turn and put the results in a dialogue box. Check the results for any fibres not found.
- Now you may simply restart the fibre configuration (**once the telescope is no longer at prime focus).**
- Finally, reset the positioner and gripper tasks back into *protected* mode.

B: Fibre Held in Jaws but Broken

If the fibre is held in the jaws, but broken somewhere behind the button, or with a missing prism, then the fibre is dead and will have to be removed from the jaws to recover use of the positioner.

- Determine if the gripper was putting a fibre down on the **fieldplate** or **park plate** (ie parking a fibre).
- The gripper is at the carrying height (7000 microns), so it is necessary to lower the Z axis to place the button on the field plate safely. Lower the Z axis to 950 microns (*Move Axis* item from the *Gantry* menu) if the fibre was being parked; otherwise lower the Z axis to 450 microns.
- Now the fibre button should be firmly on the fieldplate but still grasped in the gripper jaws. Open the gripper jaws by using the *Move Axis* command again but now selecting the *Jaw Axis* and moving to an opening distance of 900 microns (the normal jaws open distance).
- Now raise the Z axis to the normal carrying height of 7000 microns using the *Move Axis* command (NB: make sure you select the **Z** axis again after using the **jaw** axis last time).
- The next stage is to park the gripper unit: however, the positioner system still thinks it is carrying a fibre button and will not allow any other action until it is told that it is no longer carrying a fibre. To do this, first the positioner and gripper tasks must be put into unprotected mode to allow you to change an important parameter. From the 'Parameters' menu choose the 'Set privileges' item and click on the 'Gripper' and 'Positioner' tasks before clicking on the 'Continue' button. It should now be possible from the 'Parameters' menu to choose the 'Set Parameters' item for the 'Gripper' task and check the 'carrying_button' parameter. This will be set to 'yes'. Double click on the 'carrying_button' parameter and change it to 'no' before clicking on the 'tick' symbol. The positioner task will no longer protest that it is carrying a fibre.
- Now park the gripper gantry ('Gantry' menu, 'Park Gantry' item)
- With a pair of pliers carefully remove the broken fibre button from the fieldplate, and place it somewhere safe before returning it to John Stevenson.
- Now we must set the details of the broken fibre to show it to be **parked** and **disabled**.
- From the 'Fibres' menu choose the 'Set Fibre Position' item. In the dialogue window enter the fibre number and click on the correct plate and parked buttons before clicking on the 'Continue' button. The engineering interface should update to show the broken fibre now parked.
- Now disable the fibre by selecting the 'Set/Report Fibre Details' item from the fibres menu and after selecting the correct fibre click on the 'in use' button on the right hand side of the fibre information window. Then click on the 'Set Details' button at the bottom of the window: you will be prompted for a message detailing the reason the fibre is being disabled, before clicking on the 'Send' button. Please make this message accurate and informative as to the cause of the problem, as it is used to update the fibres database.
- Now unpark the gripper gantry.
- It is now advisable to check the location of the dodgy fibre and of about 10 fibres either side of the troublesome fibre. From the 'Fibres' menu choose the 'Check Fibre Positions'

item. Select the fibre range (remember to hit 'return') and click on 'Continue'. The gripper unit will centroid each fibre in turn and put the results in a dialogue box. Check the results for any fibres not found.

- Put the gripper and positioner tasks back into 'protected' mode.
- Now you may simply restart the fibre configuration (**once the telescope is no longer at prime focus access**), noting that it will give a warning message about the fibre no longer in use.

C: Fibre Held in Jaws but Severely Tilted

If the fibre is severely tilted, then recovery is similar to the case where the button was slightly tilted but still visible in the gripper tv. However, a little more care is required.

- Follow the steps for the tilted button recovery detailed above, except lower the Z axis in finer increments to the final Z height, checking at each increment that the button is un-tilting correctly and not hitting the prism before the base of the button.
- It may be possible to straighten the button slightly with very careful use of a small screwdriver....experts only please.

33.3.3 Centroid Failure After Releasing Fibre

Off-Centre Fibre Image Visible on Gripper TV Monitor

If an off-centre image of a fibre is visible in the frozen image on the gripper tv monitor, then do the following steps:

- Force the camera to grab images continuously using the 'Camera' menu and select the 'Video display mode' and later the 'Grab' item. The image on the tv monitor should vanish (if the back illumination was in blink mode).
- Turn on the back illumination in continuous mode. ('Parameters' menu, choose the 'Set/Report Task Parameters' item for the 'Gripper gantry' task. Double click on the 'backillum_always' parameter and change its value to 1 before clicking on the 'tick' symbol). The fibre image should reappear.
- Check that only one image is visible and expected. Zoom in on the engineering display and check that there are no other fibres visible around the displayed gripper position (the lost fibre will still be drawn at its original position not the current gripper position).
- Raise the Z axis to a height of 7000 microns using the 'Move Axis' command on the 'Gantry' menu, and check that the fibre image goes slightly out of focus.
- Set the back illumination mode to blink, and the out of focus image should vanish.
- Using the 'Search' item in the 'Plates' menu (or the 'torch' symbol on the toolbar), search for the fibre at the current position ('cur' button) at the 'button focus height'. The gripper will be moved to a height of about 37,000 microns and a spiral search performed starting at the current position. Once located the fibre image will be centred and the exact position in microns displayed in blue text on the engineering interface.
- The first two lines of the blue text (xf,yf) are the fibre position, and subsequent lines contain the distances of the located fibre to the nearest known fibre positions: these should be checked if there is a suspicion that the wrong fibre has been located.

- Assuming that the correct fibre has been located, it is now necessary to update its position using the 'Set Fibre Position' item from the 'Fibres' menu. Select the correct plate (normally the default is correct) and the 'to position' button then enter the x,y position of the fibre located in the search (xf, yf); if you hit 'return' after each coordinate is entered, the value of theta will be updated automatically (NB: do not enter zero!). As you click on the 'Ok' button, the fibre will be redrawn to the updated position, which should be coincident with the gripper.

- Now the software knows where the fibre is located, but it has not had its crossover information updated: **continuing a setup now would result in a horrible fibre tangle**. The safest way to proceed is to park the fibre (this is safe as it was the last fibre to be moved and is therefore on top of any other fibre). Do this by selecting the 'Parkfibre' item from the 'Fibres' menu and set the fibre range to include just the fibre you have recovered.

  Note: You may get an error message when you try to park the fibre, saying that the configuration is illegal. In this case, check the cross-over information for that fibre (with engineering interface, middle-button click on fibre in question). If you see any **red** fibres, the cross-over information has *not* been updated. **what do do then??** If all fibres are green, the fibre cross-over information has been updated okay, and you can proceed with the configuration.

- It is now advisable to check the locations of about 10 fibres either side of the troublesome fibre. From the 'Fibres' menu choose the 'Check Fibre Positions' item. Select the fibre range (remember to hit 'return') and click on 'Continue'. The gripper unit will centroid each fibre in turn and put the results in a dialogue box. Check the results for any fibres not found.

- Once the fibre has been safely parked, you may simply restart the fibre configuration (**assuming the telescope is not at prime focus access**).

Fibre Image Not Visible in Gripper TV Monitor

If the fibre is not visible, then it is likely that the fibre has either jumped a considerable distance on being released from the gripper jaws, had its prism knocked off, or had its fibre broken. In any of these cases, the positioner should be inspected after bringing the telescope down to PF access. The gripper jaws should be open but still in close proximity to the fibre button handle. This should aid identification of the correct fibre.

If the fibre is simply out of the field of view, but appears undamaged and not too near any other fibres, then simply follow the steps for recovery detailed above for the case where the fibre was visible.

If the prism is missing, the fibre broken, or the fibre simply a considerable distance away from where it is supposed to be, then it will be necessary to carefully park the fibre using a pair of small pliers.

- If the fibre is broken, it will be necessary to carefully remove the fibre from the fieldplate using a pair of small pliers. It will be necessary to park the gripper gantry first using the 'Park Gantry' item from the 'Gantry' menu).

- If the prism is missing or the fibre is a long way away from its intended destination, then carefully park the fibre using a pair of pliers. (it will be necessary to park the gripper gantry first using the 'Park Gantry' item from the 'Gantry' menu)

- Now use the 'Set Fibre Position' item from the 'Fibres' menu, to set the current fibre number to the correct value, and choose the 'Parked' button before clicking on the 'Continue' button. This will set all of the fibre details for that fibre to the parked position and set the 'parked' flag for that fibre.

- If the fibre is damaged, disable the fibre by selecting the 'Set/Report Fibre Details' item from the 'Fibres' menu. First select the correct fibre, then click on the 'in use' button on the right hand side of the fibre information window. Then click on the 'Set Details' button at the bottom of the window, You Will be prompted for a message detailing the reason the fibre is being disabled, before clicking on the 'Send' button. Please make this message accurate and informative as to the cause of the problem, as it is used to update the fibres database.

- It is now advisable to check the location of the dodgy fibre and of about 5 fibres either side of the troublesome fibre. From the 'Fibres' menu choose the 'Check Fibre Positions' item. Select the fibre range (remember to hit 'return') and click on 'Continue'. The gripper unit will centroid each fibre in turn and put the results in a dialogue box. Check the results for any fibres not found.

- It should now be safe to continue a setup, **once the telescope is safely away from PF access.**

33.4 General Note about Disabling Fibres

If any fibres have been disabled, it is a good idea to write out asap the new positioner files: from the 'Parameters' menu, 'Save Parameter Files', select 'positioner task', then 'save all files'. This saves files saying that disabled fibres are not in use, and will be picked up on subsequent configurations (NOTE: it could be that the files are only updated when you log out of the system). NOTE: any fibres disabled during a current setup will give a red but non-fatal error message, warning that it's trying to use a disabled fibre when you restart the configuration.

33.5 Z Axis Following Error

A Z axis following error occurs during a Z axis movement when the PMAC motion control card detects an abnormal difference between the expected and actual position of the Z axis encoder during the requested move. This normally happens either because the gripper has bumped into something unexpected, or because of a ghost fault arising from previous errors. Recovery will depend on whether the gripper is grasping a fibre or not.

Z axis following errors occur under two completely different circumstances. If the error occurs as part of an 'Unpark Gripper Gantry' action (probably part of a tumble), then check the Survival Guide for the relevant recovery procedure (Section **??**) ..... this is not a positioning error and its recovery is not detailed here.

However if a Z axis following error occurs while moving fibres then its recovery details are covered below.

Two possible causes of a Z axis following error are known. First, if a fibre has been manually moved, then it is possible for the gripper jaws to strike the raised handle fin and stop movement of the gripper Z axis causing a following error. Second, due to backlash in the Z axis mechanism, we occasionally see a random Z axis following error. In the first case the gripper is not carrying a fibre but in the second case the error may occur when carrying a fibre and this can make error recovery more difficult.

Examination of the tabbed error message will give information about whether the control software thinks a fibre is currently being carried or if the fibre has been moved.

Z Following Error During Pickup and Gripper Not Carrying Fibre

If the Z following error occurs during a pickup operation, and the error message indicates that the fibre has not been moved and the gripper is not carrying a fibre, then the correct recovery procedure is as follows:

- Turn on the back illumination in continuous mode. The fibre image should appear in the gripper tv monitor.
- From the 'Gantry' menu choose the 'Recover' item and then 'Raise Z'. This will raise the Z axis away from the fieldplate using the very lowest level of pmac software. You should see the fibre image in the TV moving in or out of focus.
- Once the Z axis has finished moving, do a `hard reset of the gripper gantry` ('Gantry' menu, 'Reset' item, and select the 'Gripper Task' before clicking on the 'Reset Task' button).
- Return the back illumination to blink mode
- Providing these steps all work, then you are now ready to recommence configuring a field, **provided that the telescope is not at prime focus access.**

Gripper Not Carrying a Fibre but Fibre has Been Moved

If the error message associated with the Z following error indicates that the gripper is not carrying a fibre button, but that the fibre has been moved, then the recovery procedure is similar to above except that the position of the fibre must be found and updated as follows:

- Turn on the back illumination in continuous mode. The fibre image should appear in the gripper tv monitor.
- From the 'Gantry' menu choose the 'Recover' item and then 'Raise Z'. This will raise the Z axis away from the fieldplate using the very lowest level of pmac software. You should see the fibre image in the TV moving in or out of focus.
- Once the Z axis has finished moving, do a **hard reset of the gripper gantry** ('Gantry' menu, 'reset' item and select the 'Gripper Task' before clicking on the 'Reset Task' button).
- Return the back illumination to blink mode
- From the 'Gantry' menu choose the 'Move Gantry' item and move the gripper gantry to the last known position of the gantry where the gripper Z following error occurred (the current gripper position in the error message). Choose a Z height of about 37,000.
- Using the 'Search' item in the 'Plates' menu (or the 'torch' symbol on the toolbar) search for the fibre at the current position ('cur' button) at the 'button focus height'. The gripper will be moved to a height of about 37,000 microns and a spiral search performed starting at the current position. Once located, the fibre image will be centred and the exact position in microns displayed in blue text on the engineering interface.
- The first two lines of the blue text (xf,yf) are the fibre position. Subsequent lines contain the distances of the located fibre to the nearest known fibre positions: these should be checked if there is a suspicion that the wrong fibre has been located.

- Assuming that the correct fibre has been located, it is now necessary to update its position using the 'Set Fibre Position' item from the 'Fibres' menu. Select the correct plate (normally the default is correct) and the 'to position' button then enter the x,y position of the fibre located in the search (xf, yf from previous step); if you hit return after each coordinate is entered, the value of theta will be updated automatically (NB: do not enter zero!). As you click on the 'Ok' button, the fibre will be redrawn to the updated position, which should be coincident with the gripper.
- Now the software knows where the fibre is located, but it has not had its crossover information updated: **continuing a setup now would result in a horrible fibre tangle**. The safest way to proceed is to park the fibre (this is safe as it was the last fibre to be moved and is therefore on top of any other fibre). Do this by selecting the 'Parkfibre' item from the 'Fibres' menu and set a fibre range to include just the fibre you have recovered.
- Providing these steps all work, then you are now ready to recommence configuring a field, **provided that the telescope is not at prime focus access.**

Gripper Currently Carrying a Fibre

If the Z following error message indicates that the gripper is currently carrying a fibre, then this is the most difficult case to recover, and it is recommended that each stage of the recovery is inspected at prime focus access. The difficulty is that we want to use the Z axis to lower the fibre button to the fieldplate, but this is the motor axis that has a fault.

- Turn on the back illumination in continuous mode. The fibre image should appear in the gripper tv monitor.
- From the gantry menu choose the 'Recover' item and then 'Lower Z'. This will lower the Z axis towards the fieldplate using the very lowest level of pmac software. You should see the fibre image in the TV moving into focus. Check that the fibre button has made contact with the fieldplate by inspection and if necessary repeat the lower Z command.
- From the 'Gripper Gantry' choose the 'Recover' item and then 'Open Jaws'. This will open the gripper jaws and hopefully release the fibre button and leave it firmly attached to the fieldplate.
- From the 'Gantry' menu choose the 'Recover' item and then 'Raise Z'. This will raise the Z axis away from the fieldplate using the very lowest level of pmac software. You should see the fibre image in the TV moving out of focus.
- Once the Z axis has finished moving, do a **hard reset of the gripper gantry** ('Gantry' menu, 'reset' item, and select the 'Gripper Task' before clicking on the 'Reset Task' button).
- Return the back illumination to blink mode.
- Set positioner and gripper tasks into unprotected mode so that the gripper gantry may be moved: from the 'Parameters' menu, choose the 'Set Task Operation Mode' item and click on the 'Gripper' and 'Positioner' tasks before clicking on the 'Continue' button. 2dF may think that it is still carrying a fibre: from the 'Parameters' menu choose the 'Set Parameters' item for the 'Gripper' task and check the 'carrying_button' parameter. If this is set to 'yes', double-click the 'carrying_button' parameter and change it to 'no' before clicking on the 'tick' symbol. The positioner task will no longer protest that it is carrying a fibre.

- From the 'Gantry' menu choose the 'Move Gantry' item and move the gripper gantry to the last known position of the gantry where the gripper Z following error occurred (the current gripper position in the error message). Choose a Z height of about 37,000.
- Using the 'Search' item in the 'Plates' menu (or the 'torch' symbol on the toolbar) search for the fibre at the current position ('cur' button) at the 'button focus height'. The gripper will be moved to a height of about 37,000 microns and a spiral search performed starting at the current position. Once located the fibre image will be centred and the exact position in microns displayed in blue text on the engineering interface.
- The first two lines of the blue text (xf,yf) are the fibre position. Subsequent lines contain the distances of the located fibre to the nearest known fibre positions: these should be checked if there is a suspicion that the wrong fibre has been located.
- Assuming that the correct fibre has been located, it is now necessary to update its position using the 'Set Fibre Position' item from the 'Fibres' menu. Select the correct plate (normally the default is correct) and the 'to position' button then enter the x,y position of the fibre located in the search; if you hit 'return' after each coordinate is entered, the value of theta will be updated automatically (NB: do not enter zero!). As you click on the 'Ok' button the fibre will be redrawn to the updated position, which should be coincident with the gripper.
- Now the software knows where the fibre is located, but it has not had its crossover information updated: **continuing a setup now would result in a horrible fibre tangle**. The safest way to proceed is to park the fibre (this is safe as it was the last fibre to be moved and is therefore on top of any other fibre). Do this by selecting the 'Parkfibre' item from the 'Fibres' menu and set a fibre range to include just the fibre you have recovered.
- Providing these steps all work, then you are now ready to recommence configuring a field, **provided that the telescope is not at prime focus access.**

33.6 PMAC Timeout During Grasp Operation

This error usually (it is unknown from another cause) occurs when the action to close the gripper jaw fails to complete. The higher level software times out and reports a PMAC timeout (but not a PMAC error). The software situation is that the PMAC action is still running and will continue to run until is is stopped manually. The usual hardware situation is that the gripper jaws will be closed tightly on a fibre button with the fibre on the fieldplate.

This error may occur in two situations, first, during the pickup stage, which is relatively easy to recover as the fibre has not actually been moved; and second, during a grasp as part of an iterative position correction in the putdown stage, which means that the fibre will have been moved, and as well as fixing the jaw problem the fibre details will be out of date and will require correction.

With an earlier version of the jaw encoder, a frequent problem was that the jaw encoder lost counts and was actually further closed that the software thought. Therefore, when the positioner software requested the jaw to close to say 340 microns to grasp the button handle, the jaw servo is unable to close to this distance and the motor stalls. At this point the positioner task times out as it has not received an action complete message from the pmac software within a set period (about 10sec). The error message indicates that an error has occurred when executing a pmac program but not a pmac error in itself. The problem lies in the fact that no timeouts exist for pmac programs, so the pmac card will try to close the jaw to the requested distance for ever; a reset of the gripper gantry will not work as the jaw is still busy.

Recovery should not require manual intervention but is divided into two sections depending on whether the grasp error occurred during a pickup, or during the iteration process of a putdown operation.The difference is important, since if it occurred during the putdown process the fibre will have been moved from its original location.

Grasp Error During Pickup

If you are sure that the grasp error occurred during a pickup fibre operation, then follow the following series of steps to recover. If possible wait until a science exposure is not underway; if this is not possible keep the back illumination on as little as possible. If unsure about any of the following actions, it should be possible to visually inspect the result at each stage of the recovery procedure with the telescope at prime focus access.

- Turn on the back illumination continuously. ('Parameters' menu, 'Set/Report Task Parameters' item, 'Gripper Gantry Task', parameter 'backillum_always' set to 1).
- Now recover control of the gripper jaw. First choose the 'Recover' item from the 'Gantry' menu. Select the 'JAW' button and while watching the gripper tv screen click on 'Continue'. This will send a command directly to the pmac card aborting the pmac program controlling the jaw, then opening the jaw by a small amount. The image of the fibre on the gripper tv should be seen to move very slightly as the jaw releases.
- Once you are sure that the gripper jaw has released, it is necessary to raise the Z axis to clear the button handle. However now that we have intervened at the pmac software level the higher level software is unable to communicate with the pmac card. So we raise the Z axis using the 'Recover' item from the 'Gantry' menu (as above) but clicking on the 'Raise Z' button before clicking on 'continue'. The fibre image should be seen to move out of focus.
- Now turn the back illumination back into blink mode 'Parameters'→'Set/Report Task Parameters→ 'Gripper Task'→'backillum_always' set to 0).
- The gantry is now safe. From the 'Gantry' menu choose the 'Reset' item and click on the 'Hard Reset of Gripper Gantry' button then the 'Reset Task' button to perform a hard reset of the gripper gantry (**but not the tumbler or fpi gantry).**
- Since the button was not moved, the setup may be recommenced, **once the telescope is away from prime focus access.**

Grasp Error During Putdown

If you are sure that the grasp error occurred during a putdown fibre operation, then follow the following series of steps to recover. If possible wait until a science exposure is not underway; if this is not possible keep the back illumination on as little as possible. If unsure about any of the following actions, it should be possible to visually inspect the result at each stage of the recovery procedure with the telescope at prime focus access.

- Turn on the back illumination continuously. ('Parameters' menu, 'Set/Report Parameters' item, 'Gripper Gantry Task', the parameter 'backillum_always' set to 1).
- Now recover control of the gripper jaw. Choose the 'Recover' item from the 'Gantry' menu. Select the 'Jaw' button and while watching the gripper tv screen click on 'apply'. This will send a command directly to the pmac card aborting the pmac program controlling the jaw, then opening the jaw by a small amount. The image of the fibre on the gripper tv should be seen to move very slightly as

- Once you are sure that the gripper jaw has released, it is necessary to raise the Z axis to clear the button handle. However, now that we have intervened at the pmac software level the higher level software is unable to communicate with the pmac card. So we raise the Z axis using the 'Recover' item from the 'Gantry' menu (as above) but clicking on the 'Raise Z' button before clicking on 'apply'. The fibre image should be seen to move out of focus.

- Now turn the back illumination back into blink mode

- The gantry is now safe. From the 'Gantry' menu choose the 'Reset' item and click on the 'Hard Reset of Gripper Gantry' button then the 'Reset Task' button to perform a hard reset of the gripper gantry (**but not the tumbler or fpi gantry).**

- Since the fibre has been moved from its original position, the fibre must now be located (and probably parked) before the setup can be recommenced.

- Note down on a piece of paper the current gripper X,Y coordinate from the positioner error dialogue box: this was the last known X,Y position of the gripper unit (and hence also the last position of the lost fibre).

- Move the gantry to the last known X,Y position noted down ('Move Gantry' item from the 'Gantry' menu). Use the Z height of 37,000. **NOTE:** You may get an error message that the gantry still thinks it is carrying a fibre button. In this case, the positioner system will not allow any other action until it is told that it is no longer carrying a fibre. First the positioner and gripper tasks must be put into unprotected mode to allow you to change an important parameter. From the 'Parameters' menu choose the 'Set Privileges' item and click on the 'Gripper' and 'Positioner' tasks before clicking on the 'Continue' button. It should now be possible from the 'Parameters' menu to choose the 'Set Parameters' item for the 'Gripper' task and check the 'carrying_button' parameter. This will be set to 'yes'. Double click on the 'carrying_button' parameter and change it to 'no' before clicking on the 'tick' symbol. The positioner task will no longer protest that it is carrying a fibre button.

- Using the 'Search' item in the 'Plates' menu (or the 'torch' symbol on the toolbar) search for the fibre at the current position ('cur' button) at the 'button focus height'. The gripper will be moved to a height of about 37,000 microns and a spiral search performed starting at the current position. Once located the fibre image will be centred and the exact position in microns displayed in blue text on the engineering interface.

- The first two lines of the blue text (xf,yf) are the fibre position. Subsequent lines contain the distances of the located fibre to the nearest known fibre positions: these should be checked if there is a suspicion that the wrong fibre has been located.

- Assuming that the correct fibre has been located, it is now necessary to update its position using the 'Set Fibre Position' item from the 'Fibres' menu. Select the correct plate (normally the default is correct) and the 'to position' button, then enter the x,y position of the fibre located in the search (xf,yf from previous step); if you hit return after each coordinate is entered, the value of theta will be updated automatically (NB: do not enter zero!). As you click on the 'Ok' button, the fibre will be redrawn to the updated position which should be coincident with the gripper.

- Now the software knows where the fibre is located, but it has not had its crossover information updated: **continuing a setup now would result in a horrible fibre tangle**. The safest way to proceed is to park the fibre (this is safe as it was the last fibre to be moved and is therefore on top of any other fibre). Do this by selecting the 'Parkfibre' item from the 'Fibres' menu and set a fibre range to include just the fibre you have recovered.

- Once the fibre has been safely parked, you may simply restart the fibre configuration, **assuming the telescope is not at prime focus access**.
- Finally, reset the positioner and gripper tasks back into 'protected' mode.

33.7 PMAC Timeout During Z Movement

This error has occurred in the past after a fibre button has been knocked by hand, and the button handle is no longer aligned with the radial angle expected by the gripper. When the Z axis is lowered to pick up the fibre, the gripper jaw hits the top of the button handle and can proceed no further. Eventually the higher level software (VME level) times out and complains of a PMAC timeout (not a PMAC error).

This is an extremely rare, if ever, occurrence. Normally the Z axis gives a Following Error long before it times out. No recovery details are therefore given at this time. Contact expert assistance if you suspect this error.

Chapter 34

Tumbling Errors

34.1 PMAC Error While Tumbling

During tumbling the positioner, a TUBLE function could be failed when executing the pmac program and returning a PMAC error following a Gripper Z warning. At first instance, re-initialise the gripper arm from the Gantry menu of `2dF Positioner` window. Select Hard reset of Gripper Gantry and click Reset Task.

In case of re-initialisation failure, use the web form interface to the 2dF top end network power switch. Select the **Boot** radio button from the form for the `VME_Crate`, and then hit the **Apply** button to reboot the top end power supplies VME crate.

Chapter 35

ADC Troubleshooting

In the event of an ADC error, please take extreme care as careless clicking of buttons to try and recover the ADC can cause more problems and cause significant loss of time. **A little time spent thinking here can save you a lot of 2dF restarts.**

The main error seen recently seems to be a unexpected reset of the ADC stepper motor controller. Read the error dialogues carefully, the suggested course of action is usually the best. All ADC recoveries follow the procedure outlined below, but watch for a dialogue that suggests you power cycle the ADC stepper motor controller, catching this can save a full 2dF top end restart (although it does require you to bring the telescope to prime focus access to cycle the power on the unit). The power cycle is only rarely necessary.

If repeat ADC failures occur during the night, consider carefully the need to constantly reset. If the ADC correctly reached the last requested destination, then there may not be any need to reset it for 20-40mins, and so it is often possible to finish the current observations of the current field, before resetting.

- Stop all current actions *i.e.* abort the current positioner setup and either wait until the current CCD exposure finishes, re-time it to a shorter exposure or abort it if its not been running long (taking care to set the CCD repeat counter back to single a observation).
- Issue a **hard reset** to the ADC task. This is done by selecting the *commands* menu of the `tdfct` main window and choosing the *reset* item. A dialogue box will appear and select the **by task** option. A new dialogue box will now appear: select the ADC task and click on the **hard** reset (NOT a *soft* or *full* reset) button on the right hand side before clicking on *DoIt*. This procedure will take up to 75 seconds so be patient.
- If the reset completes normally *slew to telpos* the ADC. If this works then *set tracking* and continue as normal.

If any step fails, then mark the telescope position and bring 2dF down for a full shutdown and do a full restart. If the error is "Cannot read ssx identification" this time also power cycle the ADC controller (below and to the right of the VME rack, clearly labled ADC controller) while the pos/spec MVE/power is off. Alternatively ignore the ADC and continue observing with a potential throughput loss at blue wavelengths. *Note*: The internet power switches can be used for a full shutdown and restart.

If you cycle the ADC controller watch out for it's power indicator lights. There is an LEDs on/off switch. **You must turn the LEDs back off** before taking data or there will be significant contamination in the red. Provided you are reducing your data on the fly, you will notice this contamination in the red very quickly.

Chapter 36

AAOmega - spectrograph problems

This section of contains information relevant to recovering from problems with the AAOmega spectrograph system located on the 4th floor in the West Coudé room and the adjacent instrument preparation room. AAOmega is the newest part of the observing system and as such this trouble shooting guide is not yet mature. Inappropriate action with the spectrograph can result in serious consequences for the observing system, often more serious than those associated with operation the 2dF fibre positioner components. The inexperienced user should not attempt any of the steps outlined below. The experienced user who lacks recent exposure to the system should proceed with caution, and be prepared to abort recovery and to await day time technical assistance.

36.1 No/little light in my frames

The blue camera frequently has to be moved by the day crew between observing runs. They do this to attach the vacuum pump more easily. This can leave AAOmega claiming that the camera is in position (where it was left at the end of the last run) but in fact no spectra will appear on the blue CCD while the red one is fine. Simply reconfigure the blue arm using the AAOmega gui (`tdfct`) as normal.

36.2 Computer control system - `aatlxw`

The spectrograph is controlled via `aatlxw`, which is physically located in the electronics cabinet in the Coudé west instrument preparation room. The terminal is typically left logged in, as `aatinst`.

36.3 `SPECTRO` task, `tdfct` and the engineering interfaces

Note, the low level engineering interfaces that are described in the following sections interfere with the operations of the high level `tdfct` control task and cannot be run simultaneously. The steps below describe how to start and stop this task.

36.3.1 Stopping/restarting the Spectro task `tdfct`

From the the **MMMMM** menu, select `delete task` and the `SPECTRO`.

A `Reset->Recover` will restart the task when required.

This requires that the **SPECTRO** task is running correctly on `aatlxw`, but that the low level engineering interfaces are **NOT** running, and that they have been correctly *cleaned-up*.

36.3.2 Starting/resetting the Spectro task on aatlxw

To determine if the SPECTRO task is running correctly on `aatlxw` enter into the console

```
aatlxw> ps -ef | grep -i spectro
```

which should return something along the lines of

```
aatinst 20947 20854 0 14:33 pts/2 00:00:00
/instsoft/drama/local/aaomegaSpectro/r1_70/linux_x86/spectroTask
```

kill the task with the `cleanup` command

```
aatlxw> cleanup
```

36.4 Moving the back illumination clam shell and slit clamps

The most common failure mode for the AAOmega spectrograph system has been a combination of slit clamping, slit rotation and the back illumination system. Before proceeding with the steps outlined below, it is critical that the user appreciate the potential danger faced by the fibres during manual manipulation of the slit exchange system. When using the engineering interface tools, one is relying on hardware limits to prevent accidental damage to the system and since one is only attempting these actions when the system is in a failed state, extreme caution should be exercised at all times. Every stage of the operations described below should be manually inspected to ensure that the slit vanes are appropriately clamped/unclamped before attempting any of the movements.

36.4.1 Normal slit exchange procedure

The sequence of operations required for an exchange of MOS slits, normally executed transparently via `tdfct`, is as follows:

- Open back illumination clam shell.
- Retract back illumination clam shell.
- Unclamp back illuminated slit vane.
- Unclamp beam (observing) slit vane, this is almost simultaneous with the unclamping of the other slit vane.
- Exchanges slits, via the home position if required.
- Clamp beam (new observing) slit
- Clamp back illuminated slit, fractionally after clamping of the beam slit.
- Extend back illumination clam shell.
- Close back illumination clam shell.

If a slit exchange operation has failed, physically inspect the spectrograph system and ascertain at what point the system has failed. The `tdfct` interface will have details as to whether the exchange has failed during the beginning or end of the reversible cycle of events.

To recover the system, one should use the low level engineering interfaces to place the system back into a normally operating state, recover the `tdfct spectro` task and complete the slit exchange from the control room. Note: after a exchanger failure, it is entirely possible that the slits and tumbler will be out of sync, which can be corrected from the control task with either additional tumbles (simple but slow) or with a combination of `tdfeng` tumble and/or `tdfct` slit exchange.

A typical recovery would be as follows:

- Physically inspect the slit exchanger and identify the point of failure
- Delete the `spectro` task from `tdfct` (Commands->Delete task->spectro).
- Start the `diotab` engineering interface on `aatlxw` in the fourth floor preperation room.

```
aatlxw> diotab
```

- A status GUI, with a column of buttons for various mechanisms, and with associated open/closed indicators, should appear. Each button click performs a single operation, such as "opening the clamshell" or "unclamping the beam slit". Note, there is no slit exchanger rotation option here.
- Using the toggle buttons on the diotab GUI, move the system back to a stable operating position (both slits clamped, back illumination forward and closed). Perform each operation one step at a time, and physically inspect the system at each stage. **NEVER** attempt to operate the clam shell system with out the slit vanes clamped in place, this could in principle damage the fibres if a low level interlock fails.
- Exit `diotab` using the close item on the top right of the GUI.
- Type `cleanup` to reset the control interface for `spectro`.
- restart `spectro` on `aatlxw`

```
aatlxw> spectro INITIALISE
```

  You must exit `diotab` and reset `spectro` or else the behaviour of the spectrograph component of `tdfct` will be unstable.

- In the control room, `Reset->Recover` the `tdfct` control task.

36.5 Slit Exchange System

The Slit Exchanger control must be operated with caution. No attempt to rotate the slits should be made until physically checking that both slits vanes are unclamped and that the back illumination clamshell is open AND retracted.

The slit exchanger motor is controlled via the `slittest` GUI.

- Physically inspect the slit exchanger and identify the point of failure
- Delete the `spectro` task from `tdfct` (Commands->Delete task->spectro).
- Following the instructions in the previous section, open the clam shell, retract the clam shell, release the back illuminated slit clamps and Finlay release the beam slit clamps.

- Start the `slittest` engineering interface on `aatlxw` in the fourth floor preperation room.

```
aatlxw> slittest
```

- A GUI should start with a series of buttons, entry boxes and status indicators.
- There are three predefined positions, **Positive Limit** and **Negative limit**, and **Home**.
- Below the limit buttons is a text entry box. A desired position can be entered into this section, and the rotation to this position can be commenced (after physically checking slit clamps are off and the back illumination retracted) with the start button below the box.
- If recovering from an error, first home the system, by clicking the home button. While it is running, physically check the system is moving.
- Once home, enter the desired rotator position in to the text box (auto select buttons in preparation) and move to the desired positions. The current default positions are:

```
-259903 MOS slit 0 in the beam
-76278 SPIRAL in the beam
107931 MOS slit 1 in the beam
291319 long slit in the beam
```

- Once the slit is at the correct location, reclamp the slits (beam first, then back illumination slit) using `diotab` as described in the previous section.
- Exit `diotab` and `slittest` using the close item on the top right of each GUI.
- Type `cleanup` to reset the control interface for `spectro`.
- restart `spectro` on `aatlxw`

```
aatlxw> spectro INITIALISE
```

  You must exit `diotab` and `slittest` and reset `spectro` or else the behaviour of the spectrograph component of `tdfct` will be unstable.

- In the control room, `Reset->Recover` the `tdfct` control task.

Chapter 37

Other Problems

37.1 No SkyCat windows

If for some reason the SkyCat windows are not available, you should only need to type `skycat` into the aatlxy terminal to get them back.

37.2 RED CCD Bias level issue

The RED and BLUE CCDs of AAOmega show bias variations that are far in excess of what was found in testing at the Epping Laboratory. The RED CCD bias level is more intriguing than the BLUE CCD as it occasionally drops down to zero or smaller count levels. The support astronomer should monitor the CCD performance during the afternoon by taking a set of biases and pay attention to the frames make sure count level is above 200 ADU. In case of a bias level drop taking a quick bias with `FAST` readout mode and then returning back to `NORMAL`

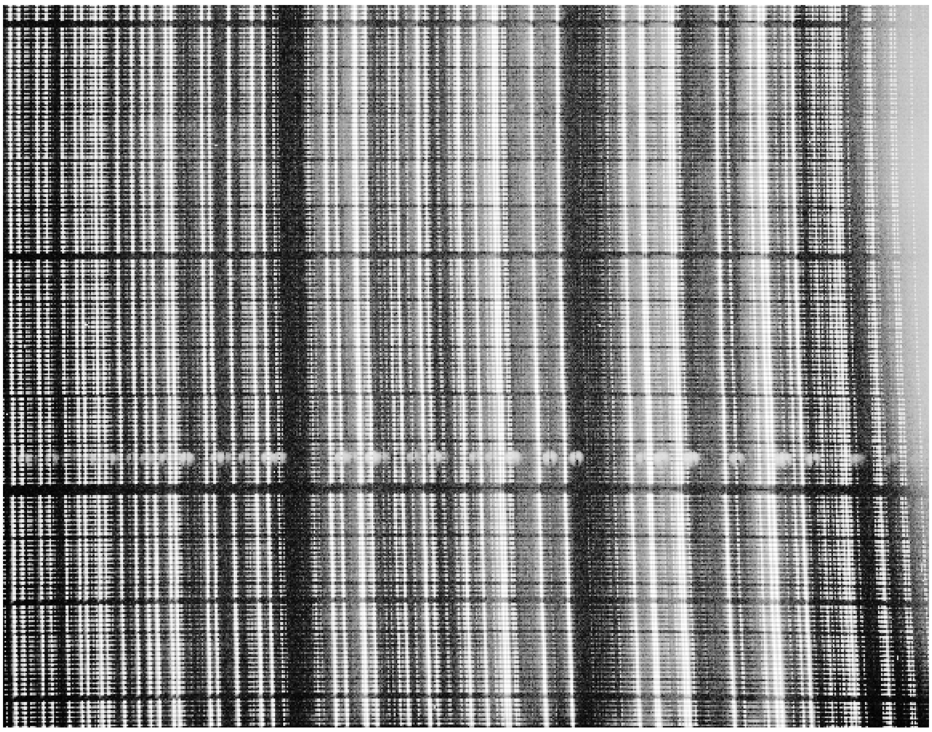

Figure 37.1: *An example of optical ghosts seen in the bottom-half of the AAOmega RED CCD arc frames taken with plate 1. For visibility cut levels are varied to show faint blobs.*

readout mode will solve the problem.

37.3 Optical ghosts in RED CCD on Plate 1

Over the past few years, the AAOmega RED CCD is showing some faint blobs or 'optical ghosts' in the data taken with the 2dF `plate 1`. Such blobs are only seen in the bottom-half of the frame (see Fig. 37.1) with varying locations and could be seen by choosing different cuts levels particularly in the arc frames. Due to their faintness, there is not impact of these optical ghosts on the science as confirmed through `2dfdr` data reduction. The strength of the ghosts should be monitored to have no effect on the science data.