Whipple Gamma-Ray Telescope Manual

VERITAS Collaboration

Version 1.5 beta

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Updated by:
John Toner

Disclaimer

While the data acquisition system is now in a relatively stable state, improvements to and changes in the system are an ongoing process. Therefore, this manual may not be completely accurate beyond the date of this version.

Errors/omissions/suggestions should be reported to Trevor Weekes:

e-mail [redacted]

You can also simply write your comments (preferably in pencil) in the version of this manual which is kept in the control room of the 10m building on Mt. Hopkins.

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Help

You will eventually run into a problem which you cannot solve. If this occurs, you should call for help from one of the local personnel. All of them have some knowledge of most of the systems but the acknowledged experts for the different parts of the system are:

Telescope hardware/tracking Trevor Weekes or John Kildea or Ken Gibbs

Electronics Deirdre Horan, John Kildea, Andy Smith

CCD Pat Moriarty (email)

Data Acquisition Software Glenn Sembroski

Observing Procedures Deirdre Horan, Andy Smith

Burst Observations Trevor Weekes, Deirdre Horan, Conor Dowdall

If you discover a problem before 10 p.m., feel free to call any of these people. There is an up-to-date phone list on the notice board beside the door to the kitchen (See Figure 2.2) and a lot of the numbers are stored in the handheld phone. After that time, you may get some grumpy responses unless the problem is a real emergency. For instance, if you cannot get the telescope stowed, you should definitely call but if you cannot seem to get the right picture to come up on the event display, it would be best to wait until the next day.

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Chapter 1

10m Checklist

A list of tasks to complete before observations start is provided. More detailed descriptions and explanations are contained in the following chapters.

Earlier in the day

1. Determine start and stop times from the VERITAS calender webpage (http://veritas.sao.arizona.edu/private/Observer-Calendar/month.php) You will need to know the password for access.

One hour before start time

1. Check the weather outside. See Appendix A.
2. Walk around telescope and make sure it will not crush anything (ladders etc). Also, check for tools that may have been left on the focus box or its support arms. Tools left in these locations tend to fall towards the mirrors when the telescope is slewed from the Home position.
3. If there has been lightning activity (or the potential for lightning), a number of systems need to be disconnected to protect them from damage. If you feel there is no risk, reconnect the GPS and the CCD camera See §8.6.
4. Check the disk space on `dir$data` on *taurus* using the command **sh dev dir$data**. If the disk space is less than about 4,000,000 blocks you will have to delete some old dataeg **delete /noconf gt032*.fz;*** . See §6.5.3.
5. Turn on mount power and tracking control box. See §2.1.
6. Turn on all the electronics if they are not already on. See Figure 2.2 and §2.1.
7. Check temperature in the electronics room and insure that the cooling system is operational.
8. Close the blinds, including the one in the electronics room; use power control where available.
9. Start LOG sheet on *draco* in directory `/home/observer` — the home directory. See §6.2.2. At the end of the night, this file will be transferred to *veritas* using `send_log` command, which is explained later (see §2.5.4), will also be pasted into an elog (See §2.6).
10. Start the tracking program (make sure to check the time on the tracking PC). See Figure 2.1. If the system time on *track10* is wrong, see §5.2.5.
11. Check that the GPS clock is working by comparing its time with the UT time on the tracking display. It is located at the top of the second electronics rack. The green indicator LED flashes green when receiving signals correctly. During the monsoon season, disconnect the GPS antenna at the end of each night and reconnect it before observation begins.

12. Start the tracking program on *track10* by typing **track** in a terminal.
13. Start the CCD program by double-clicking on the **stargaze** icon on the CCD computer. During the monsoon season, make sure to disconnect the serial connection to the CCD at the end of each night and reconnect it before observation begins.
14. Start the HV program and turn on HV to tubes approx 40 minutes before start time. This will allow the tubes to warm up before observations begin. Type **hv −cmonitor offline** to start without the current monitor which is currently not working correctly. Otherwise if you probe the tubes currents, you will crash the program. See §5.1.
15. Login as *observer* on *taurus* if not already logged in. Use password labeled on the monitor.
16. Because the interface with the GPS is currently broken, and *taurus* loses time over the course of a day, you must set the time manually with the command
    set time=DD-MMM-YYYY:HH:MM:SS
    For example **set time=02-JUN-2007:20:32:15**. Try to set it as close to the GPS time displayed above *draco's* monitor as you can. Use local (MST) time.
17. Start *GRANITE* on *taurus* by changing directory to `dir$pro` (**set def dir$pro**) and then typing **run granite**.
18. Check that discriminator settings are what they should be. See §5.5.1.

15 minutes before start time

1. Turn off the white lights and turn on the red lights. This will help your eyes to become better dark adapted.

At start time

1. Turn on the red gamma-ray warning light located near the east double door entrance in the storage room,
2. Make sure it is dark outside. Remove the focus box cover. You must not use a flashlight when doing this, so allow your eyes to become dark-adapted. Be careful when removing the focus box cover, the HV (1000V) is on!. Place cover down flat on the platform to one side of the focus box. Make sure there are no screens etc. in front of the PMTs.
3. Remove the safety bar on the front of the platform after you have uncovered the camera.
4. Check the weather before you come in (while your eyes are dark-adapted).
5. Take a laser run (See §5.4)
6. Slew to the first object to be observed. See §5.2.4.
7. Start taking data (enter `ALL` relevant run information into the `LOG FILE`). This is the only log of the night's events so be as thorough as possible! See §6.2.2.

At the end of the night

1. Turn off the HV to the tubes and exit the HV program.
2. Turn off the red warning light outside.
3. Stow the telescope and exit from the tracking program.
4. Exit from *GRANITE*.

5. Turn off the power to the tracking control box. Turn off the mount power.
6. Replace the safety bar on the platform and put the lid on the focus box.
7. Exit the CCD program by pressing `q` then `CTRL-C`.
8. Send the `LOG FILE` to the *veritas* using the `send_log` command by typing **send_log YYMMDD** at the prompt on *draco* (see §2.5.4). Then copy and paste the log text into an elog to be sent out to the people on the 10m list.
9. Transfer the data files to *veritas* using the **transfer_10** command at a *draco* prompt (see §6.5.1).
10. Turn off all monitors before leaving (to save energy: there's no need for them to be on during the day).
11. Turn off all the red lights and open some of the blinds so the day people don't have to stumble around in the dark to find a light switch.
12. Before leaving run through a mental checklist: *Telecope stowed, camera covered, HV off, mount power off....*
13. Go to bed and dream of big detections!

Chapter 2

Basic Observing Instructions: Nightly Procedures

In this chapter there are references to several computers (e.g., *taurus*, *track10*, etc.). All of these computers should have labels on their monitors to identify them. Figure 2.2, depicts the layout of the control, electronics and UPS rooms, shows the locations of most of the electronics and computers referenced in this chapter.

2.1 Earlier in the day

1. Determine the start and stop times for observations using the calender page available at
   http://veritas.sao.arizona.edu/private/Observer-Calendar/

   The start time is the Moon set time or 10 minutes before the time when the Sun drops 18° below the Western horizon, whichever is latest. The stop time is the Moon rise time or 10 minutes after the time when the Sun reaches 18° below the Eastern horizon, whichever is earlier. Note, we can start 10 minutes before and end 10 minutes after the times when the Sun is at 18° below the horizon. NOTE: This information is also available from the program *xephem* which is installed on *track10*. Start time and end time will be 10 minutes before and after the times when the sun is 18° below the horizon (indicated as dusk and dawn in the program).

   Start and finish times are not absolute in relation to moon rise and set times. It is possible to operate while the moon is visible but low in the sky. This is especially true of nights close to a new moon.

2.2 One hour before the start of the night's observations, around sunset

1. Go outside and check the weather, you can check the current humidity, temperature and wind speed on the Web at the following address, *http://linmax.sao.arizona.edu/weather/weather.html*. This page will also give you the weather trends over the last few hours. Additionally, here are some other useful sites to learn about weather conditions, which should be bookmarked in mozilla on *draco*:
   http://skycam.mmto.arizona.edu/,
   http://www.atmo.arizona.edu/products/satimage/,
   http://www.atmo.arizona.edu/products/radar/,
   http://www.weather.com/weather/cities/us_az_amado.html.

2. Walk around telescope and make sure it will not crush anything. Also, check for tools that may have been left on the focus box or its support arms. Tools left in these locations tend to fall towards the mirrors when the telescope is slewed from the Home position.

3. Check the disk space on `dir$data` on *taurus* using the command **sh dev dir$data**. If the disk space is less than about 4,000,000 blocks you will have to delete some old data. See §6.5.3.

   `setdef dir$data`
   `dir gt03*.*` ... *This gives a listing of files*
   `del /noconf gt03*.*;*` ... *This deletes data without asking for permission to delete (noconf) each file*

4. Check that the tracking computer disk is mounted on *taurus* (**show dev DNFS1**). See §2.9.3.

5. Turn on the power to the telescope drive (see §5.2.1 for more details) using the following steps.

   - The main power switch for the mount is located just inside the door to the right in the electronics room (Grey box on wall behind door).
   - Turn on the power to the telescope control box (the box with two displays in the first rack, the closest to the door of the electronics room). This will power up the interface to the telescope and open the relays providing power to all of the electronics in the mount.
   - Ensure that the azimuth and elevation enable and control switches are set at `enable` and `auto` respectively.
   - The displays should flash `DISABLED` for a second and then read out the current stow coordinates.

6. Make sure all of the other electronics is powered up: CAMAC crates, NIMs, and fan units in the electronics room. These are normally left running at all times, and it is seldom the case that people will have worked on them during the day, but it's a good idea to check.
   Don't turn on HV at this point!
   See Figure 2.2.

   NOTE: If Crate 4 has been powered down, the pattern triggers will have to be reinstalled (ref??).

7. Check temperature in the electronics room and insure that the cooling system is operational.

8. Close all the blinds in the building. There are two in the office, kitchen (only the one by the fridge works) and control room and one in the electronics room (it is easy to forget this one, though it is usually left closed).

9. Start LOG sheet on *draco* in directory `/home/observer`. See §6.2.2. At the end of the night, this file will be transfered to *veritas* and mailed to the the people on the 10m elog list (see §2.6).

10. Check that the GPS clock is working and that the time and day displayed is correct. The GPS clock has a green LCD display and an indicator LED. It is located at the top of rack 2. You should see the LED flashing green (1Hz) if all is okay. (see §5.6 if this is not the case).

11. If the tracking computer (*track10*) is not on yet (this should almost never be the case), turn it on (it is mounted in the first rack in the electronics room) and log on as *observer* with password on the monitor (and Appendix D). Start up the windows system by typing **startx**. Note: There is a replacement backup hard drive for this machine on the wire rack beside the door to the UPS room (see 2.2) if anything should happen to it.

If the tracking computer (*track10*) is already on, the screen should have a dark green background. There may or may not be windows already open on the computer. It is best to close these, after you make sure no one is using them currently. If there is someone using the window, ask them to use a different computer.

To open a terminal window on this system (RH5.1), left-click anywhere on the desktop and a menu will appear. Select xterm from the window and an outline of a window will appear wherever you move the mouse. Click whereever you would like to place the window.

To start the 10m tracking program, type **track** at the terminal window prompt. This should open a gray window labelled *Gamma Ray 10 Meter*. This window is illustrated in Figure 2.1, you should become familiar with its various controls before you attempt to move the telescope, see §5.2.4.

Once the program has started a window will pop up asking you if you checked the UTC time and date with the GPS. Verify that the UT time is the same as the time on the GPS clock on the top of the third rack in the electronics room. Then click on the `Dismiss` button. If the system time on *track10* is wrong, see §5.2.5.

If instead of the above window, the first window you get asks the question:
`Did AZ move CW to get here?`
it means either you started the tracking program before you turned on the telescope interface or you already had the telescope pointed up somewhere in the sky before you started the tracking computer. If the tracking interface is not on, then you should exit the tracking program, turn on the interface power, and then restart the tracking program. If the telescope is already pointed somewhere in the sky, you need to answer `Yes` if you moved the telescope clockwise `CW` to get it there, or `No` if you moved the telescope counter-clockwise to get it to its current position.

12. Turn on the CCD computer and start the CCD program by double clicking the **stargaze** icon then complete the following. During the monsoon season, make sure to disconnect the serial connection to the CCD in front of its control computer and the orange extension cord at the CCD camera at the end of each night and to reconnect them before observation begins.

    Compare the CCD time to the tracking computer UTC time. If the times are within 1 minute, it is okay (see §5.7.1 if they are not).

13. Start HV program and turn on HV to tubes approx 40 minutes before the Sun is 18° below the horizon or Moon set time, whichever is latest (*ie* start time). See §5.1. This will allow the tubes to warm up before observations begin.

    - Use `hv` to start the program, or `hv --cmonitor offline` to start the program without the current monitor enabled as it it currently not working correctly and can crash the program if you inadvertently try to prove the currents when it is enabled.
    - Turn on the HV in the HV program by clicking the radio button **"HV ON"** between the "Stars" and "Help" menus.
    - Wait for the voltages to ramp up (the color of the tubes will change while this happens) then make sure no tubes are off from the night before.

14. Login as *observer* on *taurus* using password from Appendix D or on the monitor. (If you are already logged in you do not have to do this again).

15. Communication between the GPS and *taurus* is not currently possible, so *GRANITE* cannot read the correct time. The backup battery on *taurus* is not as good as it once was, so the machine loses a few

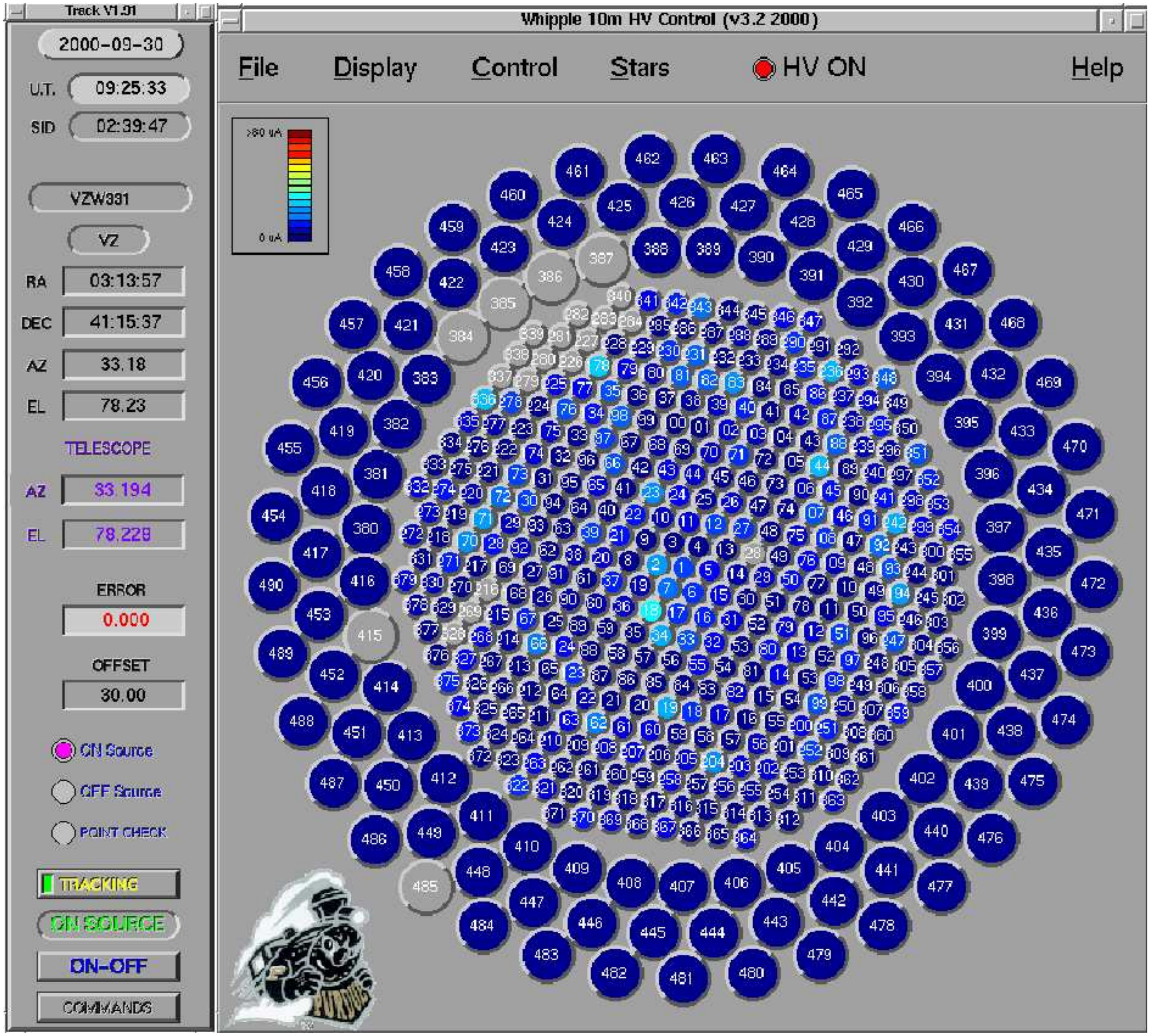

Figure 2.1: The track & HV display for the 10m telescope. Outer (larger) tubes are no longer used.

minutes of time every day. In order to have fairly accurate timeing information, you must manually set the system ina terminal before starting the data acquisition system. To do this, type:
`set time=DD-MMM-YYYY:HH:MM:SS`
For example `set time=02-JUN-2007:20:32:15`.

Try to get the time as close to the GPS time, read out on an LED display above *draco*, as possible. You should be able to get it accurate to within a second or so.

16. Start the data acquisition system (*GRANITE*) by entering the command **set def dir$pro** at the prompt. This puts you into the correct directory. Next type `run granite` or `r granite` at the prompt.

17. Check that the default discriminator settings are what you want them to be. The discriminator settings echo in the *Command History* window when the `DATA ACQUISITION SYSTEM` is started. If the discriminator thresholds are not set properly, change them to there correct setting (see §5.5.1).

18. THIS STEP ONLY APPLIES IF GPS COMMUNICATION IS RE-ESTABLISHED:
    Once the acquisition system has started, the *taurus* clock will automatically be synchronized with the GPS time using the **SYNC** command in the command input window (see Figure 7.1). When the GPS and computer times are very different, the **SYNC** command may not work. If this happens, use the command **SYNC -1**. This will force the computer to take on the GPS time. *NOTE*: make sure the year is correct on the computer; this will not be reset with **SYNC** (see §2.8.6 if the years are not the same).

2.3 About 15 minutes before the start time

1. Turn off all the white lights and turn on the red lights. This will help your eyes to become better dark-adapted.

2. Make sure you know what sources you are due to look at throughout the night, especially the first one as you may only have a small window of opportunity to observe it at a good elevation.

2.4 At start time

(a) Turn on the red gamma-ray warning light outside the storage room doors. The switch is inside the storage room double doors leading outside.

(b) Check that it is dark outside and if so, remove the focus box cover.
Be careful when removing the focus box cover, the HV (1000V) is on!

(c) Take a laser run at stow before slewing to the first source. In order to do this, you will have to:
- Power up the laser, which can be found in the UPS/optics room (See Figure 2.2).
- Go to *taurus* and take a tracking run. Stop the run after around 3 mins.
- After you stop the tracking run, you should kill *GRANITE* and restart it.

(d) You can now start taking data. From the tracking computer select the first source or the zenith and start slewing to that position using the following steps.
- To choose a source, click on the box with the source name in it. (The one labelled **VZW331** in Figure 2.1).
- A window will pop up to ask you if you want to choose a source from a list, a burst source, or change the name of the existing source. Click on the button labelled **LIST**.
- The first time you choose a source a window will pop up with a list of source files from which to choose your observation target. Click on, say, `sources.trk.primary0607`, then click on **Ready** to get into the file.
  - The next time you select a source, the program will ask if you want to use the same file for sources. Click **Yes** if you do. If you are not sure, click **No** and the program will give you the option of choosing from the different source files, say, `sources.trk.secondary0607`.

- Once in the sources file, move down the list, using the scroll bar on the right of the window, until you find the object you want to observe. Click on the source you want to observe. The program should then return you to the main window with the source you chose. Sources highlighted in `white` are setting in the local sky, those highlighted in `blue` are rising, and those highlighted in `black` are below the horizon.
- Click on `STANDBY` to change the mode to `TRACKING`. The telescope will then track the object or off source region.

3. Start taking data (enter `ALL` relevant run information into the `LOG FILE`). See §6.2.2.

2.5 Data Collection

For all runs taken, note any changes to the discriminator threshold, tubes turned off, etc..

2.5.1 Introduction

The remainder of this section contains brief descriptions of the main types of files you can collect and the preparations which you need to make in order to collect these files.

2.5.2 Preliminary Data Files

See §6.3 for more details about these files.

Laser File

This is usually the first file taken. It takes 3 minutes to complete. The telescope is triggered by a laser which evenly illuminates the face of the telescope camera. The laser produces pulses of about 4 ns length at a wavelength of 337 nm. These pulses pass through a dye which flourseces at around 400nm. See §5.4 for more details about the laser.

The laser is flashed at a rate of around 32Hz (this is adjustable). We use this file to calculate the relative gains of the phototubes. It must be taken and analyzed before the data files can be analyzed with the *Quicklook* procedure (see Chapter 3 for more details on the *Quicklook* analysis).

Instructions:

- Verify that all tubes are on.
- Do not take a laser file with a bright star in the field of view. It is best to take it at stow.
- Make sure the laser is powered on. <u>You must physicsally power it on before the run.</u> It is powered on by flicking the switch on the powerstrip to which it is connected in the UPS/optics room. There is a pilot switch which should be red when power is applied.
- Start the Laser run by clicking on the **TRACK** button in the DATA ACQ. SYSTEM (see Figure 7.1. This will start the acquisition of laser pulses.
- Enter the run information in the `LOG FILE` (see §2.5.4 and §6.2.2).
- After the run is completed <u>TURN OFF</u> the laser.

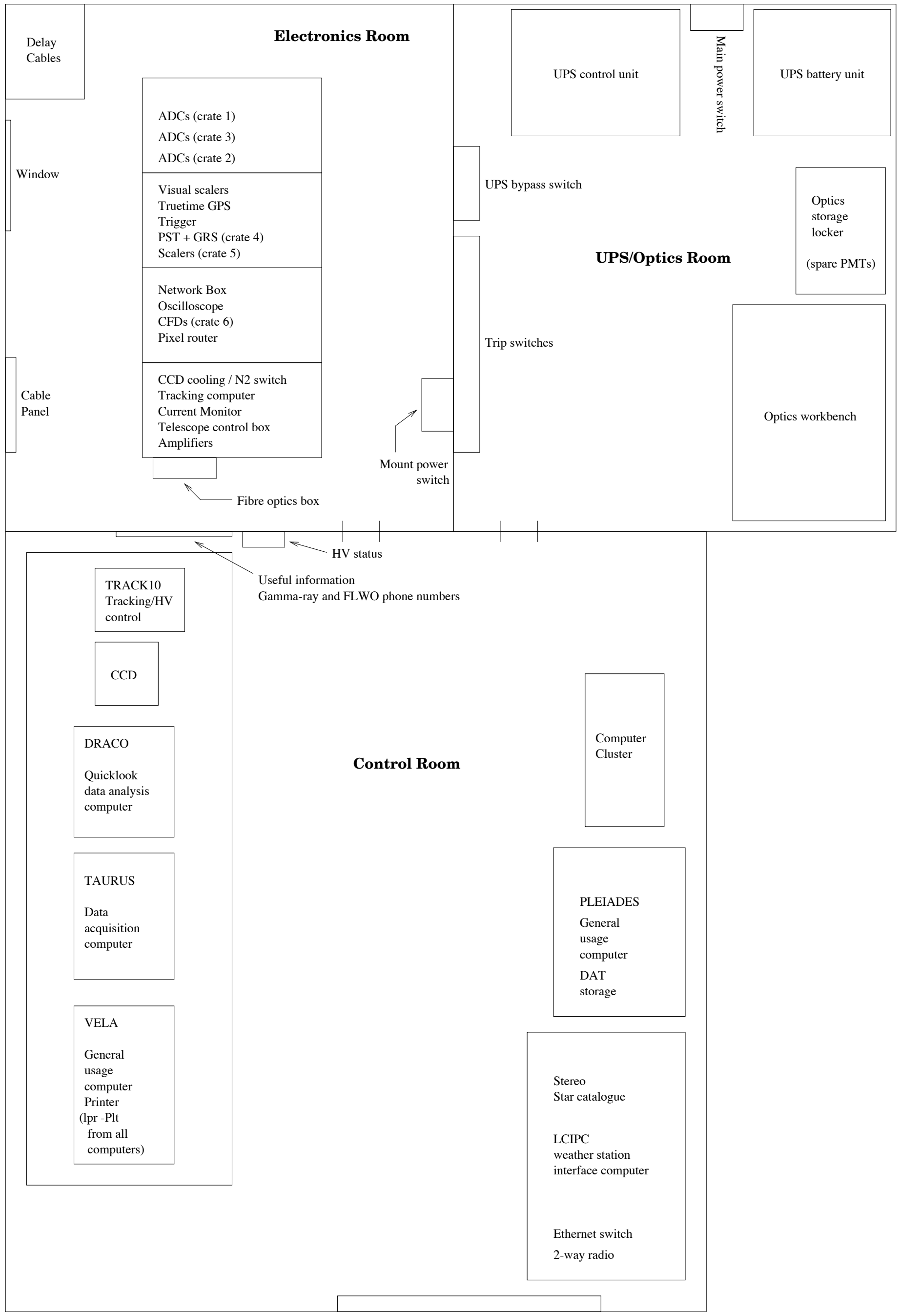

Figure 2.2: The layout of the 10m control room.

What to look for:

The event display for the `laser` run will show the ADC values for the events recorded by the telescope. The important thing to do here is to make sure that all tubes in the mean ADC value display have similar values for the mean ADC counts. If a tube has a gain which is significantly different than the others, you may need to adjust the HV of that tube. See §5.1 for directions on how to adjust the HV. Any adjustments to high voltages should be noted in the log sheet.

Zenith file

This can be done at any time during the night. It lasts 10 minutes. This data file is used for calibrating the telescope throughout the season (e.g., for Monte Carlo analyses) and for diagnostics so it should be taken at least once each night.

Instructions:

- Move the telescope to the zenith. In recent seasons, this has meant an elevation of 89°, 86°, 83°,... to allow for the Whipple Strip-Survey *(M. Kertzmann, DePauw).* Do not use an elevtion greater than 89°, and stick to the "*zenith*" angle for the season. Move the telescope using "DRIFT MODE". See §5.2.4.
- Make sure there are no bright stars in the field of view. If there are, lower the telescope elevation slightly to get them out of the field of view.
- Start the *Zenith* run by clicking on the **ZENITH** button in the DATA ACQ. SYSTEM. See Figure 7.1.
- Enter the run information in the `LOG FILE` (see §2.5.4 and §6.2.2).

2.5.3 Source data files

These data files are taken with a potential source in the field of view. The standard length for these runs is 28 minutes. Typically, the telescope is pointed directly at the location of a point source, but for extended objects (e.g., supernova remnants) the direction of the pointing will be somewhere within the area covered by the object. There are two types of data runs taken: *On/Off* and *Tracking*. *On/Off* files are taken when we want a very careful estimate of the background for a given source (e.g., for energy spectrum measurements) or if two-dimensional analysis is needed for the source (e.g., for extended objects which might have emission spread out over a measurable fraction of the field of view or for objects like egret unidentified sources whose location is not well-known).

The main difference between the two types of source runs is that for *On/Off* pairs, a control run (the *Off* run) is taken before or after the *On* run taken on source. The *Off* run must be offset in right ascension (R.A.) so that the observations track the same region of the sky in elevation and azimuth as the *On* run. If the *Off* run is taken after the *On* run, the *Off* run is offset in R.A. by +30 minutes and starts exactly 30 sidereal minutes after the *On* run. This is the default mode for taking *On/Off* pairs. If the *Off* run is taken *before* the *On* run, it is offset by -30 minutes and starts exactly 30 sidereal minutes *before* the *On* run. This type of *Off/On* run might be taken if the off-source region has a bright star in the field of view or if the source is at low elevation and is rising. See §2.8.1 for instructions on how to change the R.A. offset for taking *Off/On* pairs.

Because the *On/Off* pairs determine the background from a different run than the on-source run, they must be taken under very clear weather conditions. Take *On/Off* data only in A weather unless specified otherwise in the Observer's notebook. If clouds move in during an *On* run, an *Off* run should not be taken because it will not give an accurate measure of the background for the *On* run.

Preliminaries:

1. Select a source from the tracking computer source list (see §5.2.4 for instructions on selecting a source).

2. Slew to the on source position by clicking the circular button next to the phrase **ON SOURCE** at the left part of the tracking program display (it should be selected by default) and then clicking the **STANDBY** button to make it change to **TRACKING**.
3. Move to the pointing star by clicking the button next to **POINT CHECK** button. Do a pointing check by clicking on the **DISPLAY** pull down menu and selecting **POINTING CHECK**. See §5.2.4. Anode currents for each tube will be shown. Record the values for tubes 1-7 in the `LOG FILE` along with the sourcename, UTC, elevation, and azimuth. See sections §2.5.4 and §6.2.2 for more information on this.
4. Slew back to the source position by pressing **P** or by clicking the button next to **POINT CHECK**.

   NOTE: This pointing run can not be performed if the current monitor is not working correctly, as is currently the case.
5. Check for stars in the field of view and turn off any tubes whose current is too high (see §5.8.1 for more details) or if the tube participates in an excessive number of trigger events (see §2).

   - A tube's current can be read from the current monitor which is in the high voltage program. If the voltage is above 50 microamps turn off the tube. Such a current corresponds to a red or orange colour in the display.
   - Because the telescope drive is an altitude-azimuth mount, rather than an equatorial mount, the stars position in the field of view will change during the course of a run. For observations taken near the zenith or source transit you will probably want to turn off an extra tube or two whose currents will likely get too high during the course of the run. Sources with declinations **less than 32**° move clockwise in the field of view and sources with declinations **greater than 32**° move counterclockwise. 32° is the latitude of the observatory.
   - Note in the `LOG FILE` which tubes are turned off.
     NOTE: Again, this is currently not working. In order to see where stars should be in the field of view, the **Star Display** mode can be selected from the *Stars* menu in the HV program. This will overlay a plot of what stars should be in the field of view of the telescope.
6. If taking ON/OFF data, slew to the off position by clicking the circular button next to the phrase **OFF SOURCE** on the left of the tracking program display (see Figure 2.1). If you are taking Tracking data, ignore this step.
   - Check for stars in the off-source field of view and turn off any tubes whose current is too high (see §5.8.1 and above). Note in the `LOG FILE` which tubes are turned off. Remember that sources near transit will cause telescope to slew in azimuth a great deal and the HV display will have to be monitored closely. Tubes which were turned off for the *On* run should be left off during the *Off* run.
   - Slew back to the on-source position by clicking on the circular button above the phrase **ON SOURCE**.

On/Off pairs: Only take *On/Off* data in A weather unless specified otherwise.

- Start the first data run by clicking on the **PAIR 1/2** button in the Data Acquisition System (even if you are doing the *Off* run before the *On*). See Figure 7.1. This will begin the run on the next sidereal minute. Enter the relevant run information in the `LOG FILE` (see §2.5.4 and §6.2.2).

- At the end of the run, slew to the pair position, as explained above. Start the data run by clicking on the **PAIR 2/2** button in the Data Acquisition System (even if you are doing the *On* run second). See Figure 7.1. This will start the run exactly 30 sidereal minutes after the previous run. Enter the relevant run information in the `LOG FILE`. Make sure to leave the tubes you turned off in the *On* run off in the *OFF* run.
- To abort a run (**ON** or **OFF**), click on the **STOP** button at the lower right hand side of the data acquisition program. It's probably a good idea to exit *GRANITE* and restart (*ie* `r granite`) after aborting a run. See Figure 7.1.

Tracking runs: Tracking runs can be taken in any weather.

- Start the data run by clicking the **TRACK** button. See Figure 7.1.
- Enter the relevant run information in the `LOG FILE`.
- To abort a tracking run, click on the **STOP** button at the lower right hand side of the data acquisition program. Again, it's probably a good idea to exit *GRANITE* and restart (*ie* `r granite`) after aborting a run. See Figure 7.1.

2.5.4 Log File

All relevant information obtained during the night should be entered into the log file on *draco* and later transferred to *veritas* using the `send_log` command. The log sheets reside on *draco* and backups are made to *veritas*.

`veritas:/data/log/logs_YYY/dYYMMDD` `draco:/home/observer/`

NOTE: Passwordless ssh is the only authentication available on *veritas*. This means that if either *veritas* or *draco* are upgraded, or lose their public/private key pairs, you will not be able to transfer data or logs to the backup. If this happens, contact Ken Gibbs or Jeremy Perkins. It is important that everything gets backed up.

A template for the log file (see §6.2.2) can also be found in `draco:/home/observer`. This should be filled out completely, giving as much detail as possible about the night's activities. It is the only lasting record as to how the data was taken, weather conditions, etc. If you generate the log file on *draco* a backup is made on *veritas* when the `send_log` command is issued. The `send_log` command is executed on *draco* as follows:

send_log YYMMDD

2.6 Other tasks to complete during the night

1. Check and record the weather several times during the night. Sometimes you will need to check the weather several times during a run if the raw rate is variable to ensure that no clouds are passing through the field of view.

2. Update the `LOG FILE` if anything important occurs. This includes, but is not limited to, changes in the weather, error messages from the *COMMAND HISTORY* window, detector problems (e.g., a dead tube), explanations of why a run was aborted, Data Acquisition System crashes, problems with the tracking computer (e.g., it is not keeping up with the source), etc. This is *VERY* important as the `LOG FILE` is the only written record we have of observing difficulties.

3. Perform the *Quicklook* analysis on all data runs. Record the results in the `LOG FILE`. See Chapter 3 for a full set of quicklook instructions.

2.7 At the end of the night

1. Turn off the High Voltages using the HV program on *track10*. See §5.1.

2. Turn off the red light outside the store room.

3. Bring the telescope to its home position. See §5.2.4.

   - To do this with the tracking program, click on the **COMMANDS** button in the tracking display and then select **MOVE HOME**.
   - You can stop the computer from moving the telescope to home by typing **S** with the mouse pointer in the main tracking window.
   - Exit the tracking computer program by clicking on the **COMMANDS** button and selecting the **EXIT** option.

4. Exit the DATA ACQUISITION SYSTEM by hitting the **EXIT** button and confirming that you wish to exit the program. See Figure 7.1.

5. Move the `LOG FILE` to onto *veritas* using the `send_log` command by typing **send_log YYMMDD**. Transfer the data files to *veritas* using the **transfer_10** command at a *draco* prompt (see §6.5.1). This will bzip2 and copy the data to *veritas* and place it in the directory corresponding to the current date.

6. The `LOG FILE` is sent to those on the 10m list by posting it to an elog.

   - Go to:
     http://veritas.sao.arizona.edu:8080
     This should be bookmarked in mozilla on *draco*.
   - Select `10m Observer`.
   - Click on `New` and fill in the first 6 fields (Author, Date,...). Fill the "subject" field with the name of the `LOG FILE`, eg d070101.log_10.
   - Select all of the text in the text editor and paste it into the elog text window.
   - Click `Submit`.

7. Quit the CCD program by typing **q** then **CTRL-C**.

8. Turn off the telescope power at the tracking controller and the mount power with the switch.

9. Replace the safety bar on the platform before putting the lid back on the focus box.

10. Turn off all monitors, coffee pots, stereo, etc. Wash all of your dishes and tidy the place up. Turn off all red lights including the one outside and open the shades for people who will be entering the building during the day.

11. Have a good day's sleep.

2.8 Simple changes to default setups and displays

2.8.1 Off before On observations

If you want to collect an Off-source run before an On-source run, you need to change right ascension offset in the tracking computer. This is accomplished by clicking on the **ON-OFF** button in the tracking computer display. It will ask you if you want to take *Off-On* observations. Click on **YES**. That should be it. That field should now say **OFF-ON** instead of **ON-OFF** and the offset should now read **-30.00**. Remember to start the *Off* run in the DAQ with the **PAIR 1/2** command and the *On* run with the **PAIR 2/2** command to get the timing right on the runs. See Figure 7.1. After the *Off-On* data has been taken, remember to click on the **OFF-ON** button to return to the standard mode of operation.

2.8.2 Selecting a source from the tracking computer

1. To choose a source, click on the box with a source name in it (e.g. Polaris).
2. The first time you try to select a source, the tracking program will pop up a window with three options. Either choose a source list, a burst list, or name a source. Click on **LIST** and a series of source lists will appear. Select a source list. Click on **Ready?** to open the list. The next time you select a source, the program will ask you if you want to use the same file for sources. Click **Yes** if you do. If you are not sure, click **No** and it will give you the option of choosing from the different source lists again.

2.8.3 Change the quantity shown in the event display

In the 10m event display, the main screen shows the output of the PMT's in the camera. The values they record event-by-event (or frame-by-frame) for a given quantity are up to the observer. The observer can choose events or histograms related to the PMT signals.

Events

To dispay the signal from the PMT's click the **EVENT** button in *GRANITE*. Once here you will have several options as to what actually gets displayed (see Figure 7.1). The minute event rate is also shown for all event options.

1. **RAW [ADC]**: This displays the raw signals coming from each tube with no subtraction. NOTE: This is the setting that the data acquition system defaults to when starting.
2. **SIGNAL [ADC]**: This displays the raw signal with the pedestal values subtracted out.
3. **Trigger Map**: Displays what percentage of the time PMTs contribute to the PST on the left of the event display. Red tubes are the 10 tubes which contribute the most, blue tubes are the 10 tubes which contribute the least, and the green tubes are in between. Tubes which participate in too many events (¿ 15%) should be turned off if they affect the rate. The camera display denotes these PMTs with a mauve color.
4. **NSB [pes]**: UNDER CONSTRUCTION
5. **S-RATES [Hz]**: This displays the singles rates for each tube. (UNDER CONSTRUCTION)
6. **PED STD [DC]**: UNDER CONSTRUCTION

Histograms

This button will show histograms of the PMT signals. To view these histograms click the **HISTO** button in *GRANITE* (see Figure 7.1. Here you will be given two options as to what will be displayed.

- `EVENT RATES`: This will display the buffer depth as well as the event rate of the camera for each minute of the run and each second of the current minute along with the last thirty seconds of the previous minute.

- `ADC SPECTRA`: This will display the number of counts each ADC channel receives during the run, color coded by size of the ADC value.

2.8.4 Change the range of values in the event display

In the Event display of the tubes in the camera, the relative size of the filled circles in each PMT location is proportional to the relative size of the quantity which the PMT recorded for that event. However, the absolute size of the filled circles is determined by their percentage of the value set by the slide bar to the right of the display (see Figure 7.1). This range is indicated in the lower right hand corner of the tube display plot. We have tried to make the default range indicative of the levels expected from most events under normal operating conditions. But with a changing camera and different tests being performed with the telescope, the range of the values displayed may not be adequate for your needs. To change the range of values in the display, simply use the slide bar to the value you want a filled tube to represent. All tubes will fill proportionally to this value.

2.8.5 Set the run number

If for some reason you need to set the run number to something different than what *GRANITE* thinks should be the next run, you simply click the run number button in the **RUN INFORMATION** window (see Figure 7.1). A new window will open and the desired run number of the next run can be entered here. *Be careful* with this command because if you set the run number lower than the highest run number on disk, there will be multiple versions of the same numbered run on disk. To see which run numbers are on disk, enter the command **d dir$data** from a *taurus* prompt.

2.8.6 Set the time on *taurus*

To set the time and date, use the command **SET TIME=dd-mmm-yyyy:hh:mm:ss.s** at the *taurus* prompt in the observer account. To change the year, use the command **SET TIME=dd-mmm-yyyy**. This will change the date but the time will be read from the computer. `NOTE:` The times and dates entered with this command should be in LOCAL time. Also the times should be entered as 24 hr. times. The entry for the month should be the three letter abbreviation for that month.

2.9 Common problems and their (possible) solutions

2.9.1 The *taurus* clock time is way off

NOTE: These commands will not work as long as communication between the GPS and *taurus* does not functions properly, which is currently the case.

Once the acquisition system has started, it automatically synchronizes the taurus clock with the GPS time by entering the **SYNC** command in the command input window. When the GPS and computer times are very different, the **SYNC** command may not work. If this happens, use the command **SYNC**

-1. This will force the computer to take on the GPS time. *NOTE*: make sure the year is correct on the computer; this will not be reset with `SYNC` (see §2.8.6 if the years are not the same).

2.9.2 The *track10* clock time is way off

See §5.2.5.

2.9.3 The *track10* disk is not mounted on *taurus*

If you enter the command `show device DNFS1` at the *taurus* prompt and do not get the following:

```
Device          Device    Error   Volume     Free  Trans Mnt
 Name           Status    Count    Label    Blocks Count Cnt
DNFS1:          Mounted       0  TRACK10         0     1   1
```

It means the tracking computer hard drive is not mounted on *taurus*. Take the following steps to mount it again:

1. At a *taurus* prompt, enter the command **set host 0** to get a login prompt.
2. Log in as *system* using the password from Appendix D.
3. Enter the command **mount_track10** to mount the disk.
4. Check that it worked by entering the command **show device DNFS1**. If it worked, logout by entering the command **lo** at the prompt. If it did not, try again and then call for help if it does not work the second time.

2.9.4 The telescope stopped moving

Try to move the telescope in manual mode using the tracking interface in the electronics room. To do this, you will need to have exited the tracking program on *track10*. Switch the elevation and azimuth switches from "Auto" to "Manual", then use the knobs to steer the telescope. This usually requires 2 people — one to watch as the other mans the controls. Get help if you need it. If you are on your own and in a bad way, think of phoning the VERITAS observers or asking the 60" observer for some help.

Be very careful when moving the telescope in this way. Make sure that the telescope is at an elevation greater than 15° when moving to 0° azimuth. Only then should you think of moving to a lower elevation. Getting the telescope close to stow is better than crashing it into something while trying to get it to its exact home position. See §5.2.5.

Don't panic, unless it's close to sunrise and you are pointing east. There is an emergency procedure to manually bring the telescope back to stow in case of an emergency. This is a last resort measure. Before observing on the telescope, you should familiarise yourself with this procedure. The laptop can be found on the wire rack shelf beside the door to the UPS/optics room. It is labeled appropriately. Inside the laptop case you will find step-by-step instructions (with diagrams) showing you how to move the telescope.

2.9.5 The CW/CCW button screen pops up on *track10*

See §5.2.5.

2.9.6 *GRANITE* crashed beacuse it could not talk to one or more crate(s)

The ECC (crate controller) software has probably crashed. You just need to restart the process. This is a solution to a lot of the “Granite won’t start...” problems. See §5.5.2 and §7.3.4.

2.9.7 The power has been recycled to the crates, *GRANITE* restarted, and the rate is now too high

When the power to the Pattern Trigger in crate 4 has been recycled, it must be reset to the correct multiplicity and its memory loaded with the file of valid patterns of pixels. There are two ways to do this. There is a script in *dir$pro* on *taurus* called GPR10.KUMAC. This script is run every time *GRANITE* is started. The following three lines are located near the end of this script and each are commented out with *..

```
producer10/set/pst/multiplicity    4   -1    #
producer10/set/pst/load            4    0    PST_MUL#.DAT
producer10/set/pst/verify          4    0    PST_MUL#.DAT
```

Here # is the multiplicity of the pattern trigger. It is currently *3*. To reload the Pattern Trigger you can either remove the comment marks (*..) from in front of these lines, save *GPR10.KUMAC* and restart *GRANITE*, or simply type the 3 lines by hand in the command input window of *GRANITE* (see Figure 7.1). If you do change *GPR10.KUMAC* and restart *GRANITE*, don’t forget to re-comment out the 3 lines, so the Pattern Trigger isn’t loaded every time *GRANITE* is started.

N.B. As the load and verify operations take 4 minutes in total you should avoid cycling the power to crate 4 in desperation during the night as far as possible - settle for flicking the crate controller reset switch!

To edit this file you will need a text editor. On *taurus*, the standard one to use is **XLSE**. Simply typing *XLSE GPR10.kumac* should open the editor for you and allow you to change the script. If the license has run out on **XLSE** and hasn’t been updated, then you will have to ftp into *taurus* from *draco* and get the file, edit it with emacs, or your favourite text editor, save the new file and ftp it back to *taurus*.

See §8.2 for more detail.

2.9.8 The humidity is high, the rate is too high, and there are many two pixel events

When the humidity is very high (70% or above) arcing may occur between neighbouring PMTs. If the arcing is at the back of the camera, there will be a large number ot two pixel events involving the arcing tubes only. If the arcing is at the front of the camera, the spark may trigger a large portion of the camera. In either event, the rate will be very high. There is a program on *draco* that shows the distribution of the locations of the triggering tubes. Once the run has been analyzed, in the source directory, type **tubeview max*.dat**. A display will appear showing the camera, the colour of each tube corresponding to the number of triggers. The distribution of max1 and max2 can each be viewed. There are several options for the colour scale (linear, log, and significance). If there is arcing there should be a tube (or tubes) with a very large number of max1 triggers, and a neighbour with a large number of max2 triggers. If arcing occurs, the HV should be turned `OFF` immediately. Observing can be resumed if the humidity drops.

2.9.9 The rate increases significantly and the HV display doesn’t show any hot tubes

Select **Trigger Map** in the DAQ window and see if some tubes are participating in a large percentage of the events (ie.> 15%). Turn these tubes off by right-clicking on them in the HV display. This should cause the rate to drop.

To read an existing run file and display events offline, type the command **exec granite#start_offline file=dir$date; gt??????.fz** in the command input box.

Chapter 3

Quicklook Data Analysis

The *Quicklook* data analysis package was developed so that observers could check for γ-ray emission and also conduct minor diagnostic tests. We would like the quicklook analysis to be done on every data file collected for each night of observing, including the zenith file. By analyzing the nitrogen files we establish a large database of tube gains which makes further analysis of source data easier, and also permits studies of the long-term behavior of the PMTs. Analyzing the source files establishes a database for each source which can easily be compiled to make a first pass test for emission. Finally, by entering this information in the `LOG FILE` (see §2.5.4 and §6.2.2) it allows our non-local collaborators to quickly determine the status of the objects we observe.

Comments and suggestions should be directed to Deirdre Horan ([redacted]).

In this Chapter, we discuss how to run the Whipple *Quicklook* analysis and what to look for in the plots to spot problems. The first section contains the basics of how to run the analysis on the mountain. The second describes the plots and files that are created, and what to look for in them. The third section discusses how to implement a few simple variations on the default options for the quicklook.

3.1 *Quicklook* basics

The quicklook analysis runs on the mountain on the machine *draco*, a Linux workstation that uses the Fedora Core 2 operating system. This machine takes less than 1 minute to completely analyze a *Tracking* run or an *On/Off* pair. This is used (almost) exclusively for doing the quicklook analysis and completing the log, so it should not be loaded down by other people's analysis.

To get the *Quicklook* going, complete the following steps.

1. Log in as `observer` on *draco* using password from Appendix D if it has not already been done which would be very rare.
2. Change directories to `/draco/quicklook` (with the command **cd /draco/quicklook**).

    - Enter the command **ls** and see what sub-directories already exist there. If the source is in the secondary sources tracking list, its subdirectory may be in the *SECONDARY* directory. If the source you are going to analyze already has a directory, do nothing yet.
    - If the source you are going to analyze does not have a directory, make one (with the command **mkdir sourcename**) with a name that is easy to recognize as the source but not so long as to induce carpal tunnel syndrome from typing it in. For example, `wcomae` is a good name, `wc` and `wcomae-aka-on231-aka-1es1218+285-aka-gro12187+2877` are not.

3. Move to the source directory.
4. Make a *Quicklook* command file.

   - The format for the names of these files is `ss.utdate` where `ss` is the source's abbreviation as listed on the tracking program display and `utdate` is the UTC date on which the observing is occurring. Thus, for analysis of the Mrk421 data taken on UT date May 1, 2007, the command file would have the name `m4.070501`. Make one file for the night for each source and put all of the runs for that source in this file so that you can sum up the data for the source.
   - Inside this file, you should put, at a minimum, the lines listed below. Other options (such as forcing a particular right ascension or declination) are discussed in §3.3.
     - **source sourcename**: This just tells the quicklook the source's name. Do not leave spaces in the source's name (ie. CasA instead of Cas A).
     - **n2 gtmmmmmm utdate**: This entry is to analyze the laser run used for gain estimates for the night's runs. `mmmmmm` is the run number of the laser file. *If the laser file has been analyzed already, this entry is no longer necessary and can be commented out using an ! in front of the n2.* The reason "n2" is used is that a nitrogen pulser used to be used to illuminate the camera for gain estimation.
     - **pr gtononon gtoffoff n2n2 utdate**: This is an ON/OFF run entry for the quicklook. `ononon` is the on-source run number, `offoff` is the off-source run number, `n2n2` (ie. 3151) indicates the last four digits of the run number of the laser file used to determine the gains for the PMTs in the run, `utdate` is the UTC date in the same format as used in naming the command file. *For a Tracking run, the only change is that* `gtoffoff` *should be replaced by* `none`.
   - Thus a command file might contain the following:

     ```
     source mrk421
     n2 gt015150 000501
     pr gt015151 none 5150 000501
     pr gt015152 none 5150 000501
     pr gt015153 none 5150 000501
     pr gt015154 none 5150 000501
     pr gt015155 none 5150 000501
     pr gt015156 none 5150 000501
     pr gt015157 gt015158 5150 000501
     ```

     Where the last line suggests a pair (gt015158/gt015159 -¿ ON/OFF), and the others pr lines are tracking runs.
   - Note: After the n2 run has been analyzed, you can comment out that line with an ! symbol. It need only be analyzed once a night.

5. After the acqusition of the run you want to analyze (run `nnnnnn` from now on) has completed, transfer it to *draco* from the data acquisition computer *taurus* using the command **get #####** on *draco* when logged in as `observer`. For example to transfer *gt012345.fz* type **get 12345**. More than one file can be transfered by entering more run numbers on the command line. This will copy the file to `/data/raw10/utdate` where `utdate` is the current UTC date.
6. To run the analysis programs, in the directory where you made the command file, enter the command **analyze ss.utdate pc** where `ss.utdate` is the command file name, and `pc` is an option that

minimizes the amount of space taken up by the files. Note: pc stands for politically correct in case you were wondering.

So the example above would look something like this (say the command file was called **m4.000501**):

$ get 15150 15151 15152... $ analyze m4.000501 pc

- If you want to be able to look back at the screen output from the quicklook programs (a good idea in general), use the following to start the analysis:

  `analyze ss.utdate pc |& tee out.log`

  The part after `pc` splits the screen output off (using the `tee` command) to the file `out.log`. This file can then be looked at when the analysis completes. Use any name you want for this file.

7. If all is well, you can sit back (briefly) and enjoy the show.
8. When the analysis is complete, *analyze* will ask you if you want to clean up the files created during the analysis. Answer **y** and then again for each file it asks about. This will save disk space and make sure the analysis runs properly the next time you do it.

3.2 *Quicklook* Output

The analysis currently puts out a whole load of information to the screen, writes some of the information to files, writes parameter values for each event and its timing information to a PAW ntuple, and makes up to 4 plots per run. This section attempts to help you sift through the mounds of data to find what you want and need to know. This is done below by discussing the various printouts and plots you will see when running the analysis.

Note for those of us who never had to eat PAW for breakfast: An ntuple is simply a set of events, where for each event the value of a number of variables is recorded. An Ntuple can be viewed as a table with each row corresponding to one event and each column corresponding to given variable.

Before beginning that discussion, I first list here the main programs used in the analysis to perform various aspects of the analysis.

fz2red This program takes the data from the ZEBRA file (`gtnnnnnn.fz`), does a minimal amount of processing of that data and converts it to what we call the reduced format (`gtnnnn` - note the loss of the leading two digits in the run number), which is an unformatted Fortran binary file. It also does a fair number of diagnostic checks.

gcpeds This program calculates the pedestal and pedestal variance of each PMT and the PMTs turned off for the run being analyzed and writes that information to database files in the directory `/usr/dbgt`. It gets the data from the reduced data file. It only does this calculation if the run is not already in the database. The file containing the pedestal values is `hrcYYn.cpeds` and the file containing the list of turned off PMTs is `hrcYYn.ntubelist` where `YY` are the last two digits of the year in which the run was taken and `n` is `a` if the run was taken in the first 6 months of the year and `b` if taken in the second 6 months.

gparamdat This program reads in the data from the reduced data file, parameterizes it, and writes it out to a PAW ntuple file (`gtnnnn.rz`).

PAW Plots These are created from the ntuple, not by real programs per se, but rather a series of script files (called kumacs in PAW parlance) that read in the ntuple and perform some cuts or other operations on the data and then plot up the results. The kumac files are called `diagnostic.kumac`, `quicklook.kumac`, and `alphatot.kumac`. The output from these kumac files is discussed in more detail below.

The output from the quicklook is pretty copious and can be daunting to look at if you don't have some filter for the information. Hopefully, the brief discussion will help you do that in a limited way. The discussion is grouped by what is in each output file or plot that you will see on the screen (or won't see). For each file or plot we list the things you should look for to see if there are problems. The discussion is roughly in the order in which the output occurs.

gtnnnn.inf This is an information file created in *fz2red*. It contains some summary information about the run derived from the data file. An example of this file is shown in Figure 3.1. There is actually more listed in the file, such as pedestal values and gains for all PMTs, but to keep this simple, we just discuss the parts shown in the figure.

What to look for in this file:

- Tracking section
  - Mean and RMS tracking errors should be $\ll 0.1°$ - if they are not, the tracking can significantly affect our ability to detect a source.
- Weather section
  - Check that the RMS event rate is $\sim 1\sigma$. If it is much higher, the weather may be bad (you should already know this from your usual checks of the weather).
  - The CCD information is not in the data stream at this time.
- High Voltage section
  - The HV records consists of a list of PMTs turned off. Make sure they agree with what you expect.
- Singles Rates section
  - This lists the highest and lowest 5 singles rates PMTs. If the rates are well above 500 Hz, they might have a star in their field or need to have their HV turned down.
- Event and Run Timing section
  - The GPS-osc deviation should average <1 msec. If it is bigger, there could be clock problems.
  - The Median Est. 10 MHz frequency should be within 1 part in 10^5 of the Nominal frequency (listed above it). Large differences could be due to clock rollovers or clock problems.
  - The Live time should be within 1-5% of the elapsed time. If not, there are problems.
- Breakdown of Events section
  - Make sure the number of events and injected pedestal events are what you expect. For the pedestals, there should be 1/second ($\approx$ 1680 for a 28 minute run).

gtnnnn.errors This file is also produced in `fz2red` and lists important errors in the data detected there that need immediate attention. Make sure you check this for each run to quickly identify problems.

```
Run Information:
---------------
10m RUN                  : 5910
UT Date                  : 20001005
Source                   : 1es2344
Mode                     :  1

Tracking:
--------
RA [hhmmss.s]            :  234704.8
DEC [ddmmss.s]           :  514217.9
Ave. EL [deg]            :   68.161
Mean tracking error [deg]:    0.003
RMS tracking error [deg] :    0.002
AZ (track comp.) [deg]   :  345.421
AZ (first evt calc) [deg]:  -14.384
EL (track comp.) [deg]   :   69.066
EL (first evt calc) [deg]:   69.095

Weather:
-------
Sky quality              :     A
Mean event rate [min^-1] :  2081.94
RMS event rate [sigma]   :     1.02
CCD star at (     0,     0)  Amplitude:     0
CCD star at (     0,     0)  Amplitude:     0
CCD star at (     0,     0)  Amplitude:     0

High Voltage:
------------
PMTs turned off according to HV records
---------------------------------------
415 485

Singles Rates:
-------------
 FZ ** No singles rate records in this run.

Event and Run Timing:
--------------------
GPS [yr day hh:mm:ss.ss] : 2000 279  6:46:29.50
Sidereal start time (GPS):  0:19:58.5
Sid. start time (VHEGRO) :  0:19:58.2
Sid. time last evt (GPS) :  0:48: 1.4
Sid duration (GPS) [min] :  28.05
Nom. sid run length [min]:  28.00
Nom. sid cycle time [min]:  30.00
Track comp RA offset[min]:  30.00
UTC start MJD (GPS)      :  51822.28229
UTC start MJD (VHEGRO)   :  51822.28228
UTC end [mjd]            :  51822.30167
UTC last event [mjd]     :  51822.28158
First sidereal minute    :   20
First UT minute          :  647

Mean GPS-osc. dev [ms]   :       0.013
Nominal elapsed osc. freq. [Hz]   : 0.99999923E+07
Ave. est. 10 MHz osc. freq. [Hz]  : 0.99999907E+07
Std. dev. of est. freq. [Hz]      : 0.13207681E+03
Median est. 10 MHz osc. freq. [Hz]: 0.99999913E+07
Number of gps second marks                 :    0
Run duration (elapsed UT from oscillator): 1678.276
Run duration (elapsed GPS time [s])      : 1678.228
Live time (UT seconds)                   : 1652.581 ( 98.47%)

Breakdown of Events:
-------------------
Number of events (code 8)                :  56520
Number of injected ped events            :   1647
Number of minute mark events             :      0
```

Figure 3.1: `gt5910.inf` – an example of a `gtnnnn.inf` file.

gtnnnn_ql.ps This is the first plot you will see in the quicklook. It is created by the kumac file `quicklook.kumac` using the ntuple containing the parameter distributions. An example of this plot is shown in Figure 3.2 below.

Note: The output the observer sees consists of only 7 plots, but all the plots explained here are in the gtnnnn_ql.ps file.

What to look for in this printout:

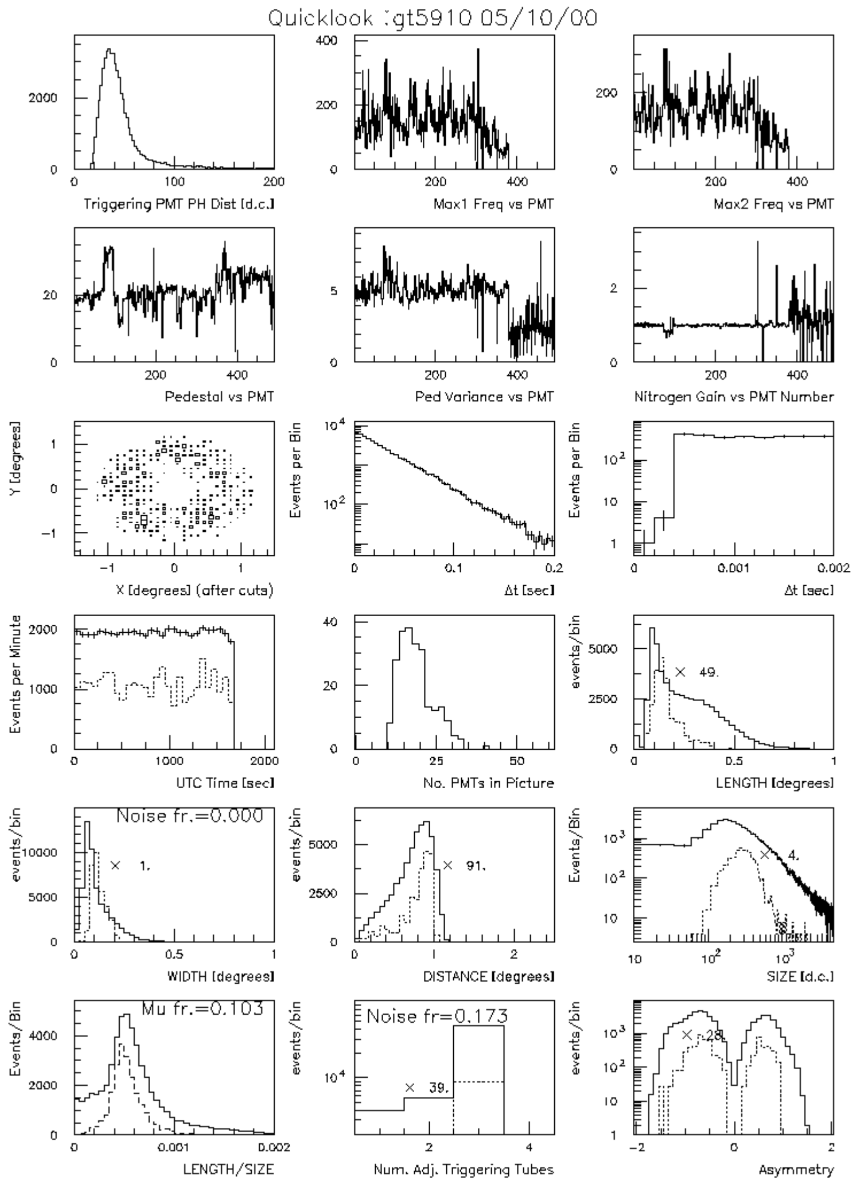

Figure 3.2: `gt5910_ql.ps` – an example of the output from `quicklook.kumac`.

- The left plot on the top row indicates the ADC counts recorded by the second highest PMT in each event. This is as close as we can currently get to the PMT which triggered the camera. The spike at about 30 d.c. indicates that, in this run, the telescope was two-fold triggering. A lower value might show if the telescope was triggering on single PMTs in error.
- The middle and right plots on the top row show the number of events in which each PMT is max1 or max2 for the run, respectively. They can identify PMTs which are triggering the camera excessively.

- The left and middle plots in the second row are the pedestal and pedestal variance of each PMT for the run, respectively. Look for abnormally low or high pedestals. Also, if the pedestal variance is high for a PMT, it may have a star in its field or its HV may need to be reduced. A low pedestal variance indicates that the HV is too low or turned off.
- The right plot in the second row shows the gain corrections for the PMTs. A high value here indicates that the PMTs gain is low and may need to have its HV adjusted.
- The left plot in the third row shows the centroid location in the plane of the camera for events identified as gamma rays. If they all come from one spot of the camera, this is a problem. This has not happened in the last 5 years.
- The middle and right plot in the third row show the time between events for two different time scales. We expect an exponential Poisson distribution of events. The middle plot should show a straight line because it is plotted in semi-log space. If it shows spikes at a particular time difference it may indicate a stuck bit in the elapsed time oscillator.
- The left plot in the fourth row shows the trigger events per minute versus elapsed time in the run (solid curve) and the events passing cuts per minute (dashed curve) after being multiplied by a large factor to make them visible. The trigger rate should be relatively flat in good weather. Varying rates will indicate clouds, which you should already know about from other indicators, or electronic problems. The events passing cuts could, in principle, identify a large flare within a run, but this has never been seen.
- The middle plot in the fourth row shows the number of PMTs in the picture for each event passing all cuts.
- The right plot in the fourth row shows the length distribution for all events (solid histogram) and those passing all cuts but length (dashed curve) after multiplication by the listed factor (49). The spikes in the solid histogram indicate one and two pixel events.
- The left plot in the fifth row shows the width distribution for all events (solid histogram) and those passing all cuts but width (dashed curve) after multiplication by the listed factor (1). A spike at 0 width is from one and two pixel events (which are probably noise triggers or cosmic rays passing through the camera) and the number listed in the plot lists what fraction of the events are contained in that bin (0.000).
- The middle plot in the fifth row shows the distance distribution for all events (solid histogram) and those passing all cuts but distance (dashed curve) after multiplication by the listed factor (91).
- The right plot in the fifth row shows the size distribution for all events (solid histogram) and those passing all cuts but size (dashed curve) after multiplication by the listed factor (4).
- The left plot in the sixth row shows the distribution of length/size for all events (solid histogram) and those passing all cuts but length/size (dashed histogram) after multiplication by a factor. Short arcs from muons should show up as a sizeable bump around 0.001 or above. Thus, we use the fraction of events above 0.001 as an estimate of the muon fraction for the run (0.103).
- The middle plot in the sixth row shows the distribution of the neighbor value for all events (solid histogram) and those events passing all other cuts (dashed histogram) after being multiplied by the factor shown (39). A value of 1 indicates that there are only isolated pixels in the image. A value of 2 indicates that only two PMTs in the image are adjacent. A value of 3 indicates that three or more PMTs in the image are adjacent. Only events with 3 or more PMTs in the image are analyzeable so we define the fraction of events with neigbor values of 1 or 2 as the noise fraction for the run (0.173).

- The right plot in the sixth row shows the asymmetry distribution for all events (solid histogram) and those events passing all other cuts (dashed histogram) after being multiplied by the listed factor (28).

gtnnnn_dg.ps This is the second plot you will see in the quicklook. It is created with the kumac file `diagnostic.kumac` using the histogram file `gtnnnn_d.hbook` created by `fz2red`. An example of the plot is shown in figure 3.3 below. This is a new plot this season (2000/01) so we will learn more about what is useful with these as we go along.

Note: The output the observer sees consists of only 5 plots, but all the plots explained here are in the gtnnnn_dg.ps file.

What to look for in these plots:

- Tracking plots: These comprise the 4 plots in the top row and the left plot in the second row from the top.
  - The plot showing the tracking deviation (left plot on top row) should have all the tracking deviations at $\ll 0.1°$. If they are not, it may indicate tracking problems or that the telescope was not on-source when the run started.
- Timing check plots - these are the right plot on the first row and the left and middle plots in the 2nd row. They are meaningless for data taken before 970901.
  - The plot showing GPS-El. scaler should show an ∼msec wide peak close to 0 deviation. There are a few outliers in this one, perhaps from elapsed scaler rollovers. If the times are spread all over, the elapsed time scaler is most likely misbehaving and should be looked at.
  - The plot showing mean GPS - EL time versus time (left plot in the 2nd row) in the run should show a line with little scatter about it. A large deviation from the line probably means that the elapsed oscillator rolled over at some point. This happens frequently now, but later will hopefully be a cause for alarm. If we knew the exact frequency of the oscillator used to calculate the elapsed time, this line would have a slope of 0. This plot indicates that the exact frequency is very slightly different than the 9.999992 MHz used.
  - The plot of Oscillator frequency - Nominal (middle plot in second row) is calculated from the times of pedestal events (which should occur on GPS second marks which are accurate to a few 100 nsec) and should be centered near 0. A shift in the position of the central peak is indicative of changes in the oscillator frequency. The outliers are a concern, but their cause has not been resolved yet.
- Trigger bits plot - this is the right plot in row 2. Each possible combination of trigger is listed, including forbidden ones. `Ped` indicates pedestal events, `PST` indicates events where the pattern selection trigger bit is set, and `Trg` indicates events for which the simple n-fold trigger bit is set.
  - `PST` should not have more triggers than `Trg`.
  - `Ped` events should never have bits set when `PST` or `Trg` do.
  - `PST` should never trigger when `Trg` does not.
  - There should never be no trigger bit set for an event.
- HV/Current plots - these are the left and middle plots in the bottom row. They show the HV and anode currents for each PMT as recorded in the last HV record.
  - PMTs which are turned off will have a HV set at 0. Make sure they agree with what you expect.

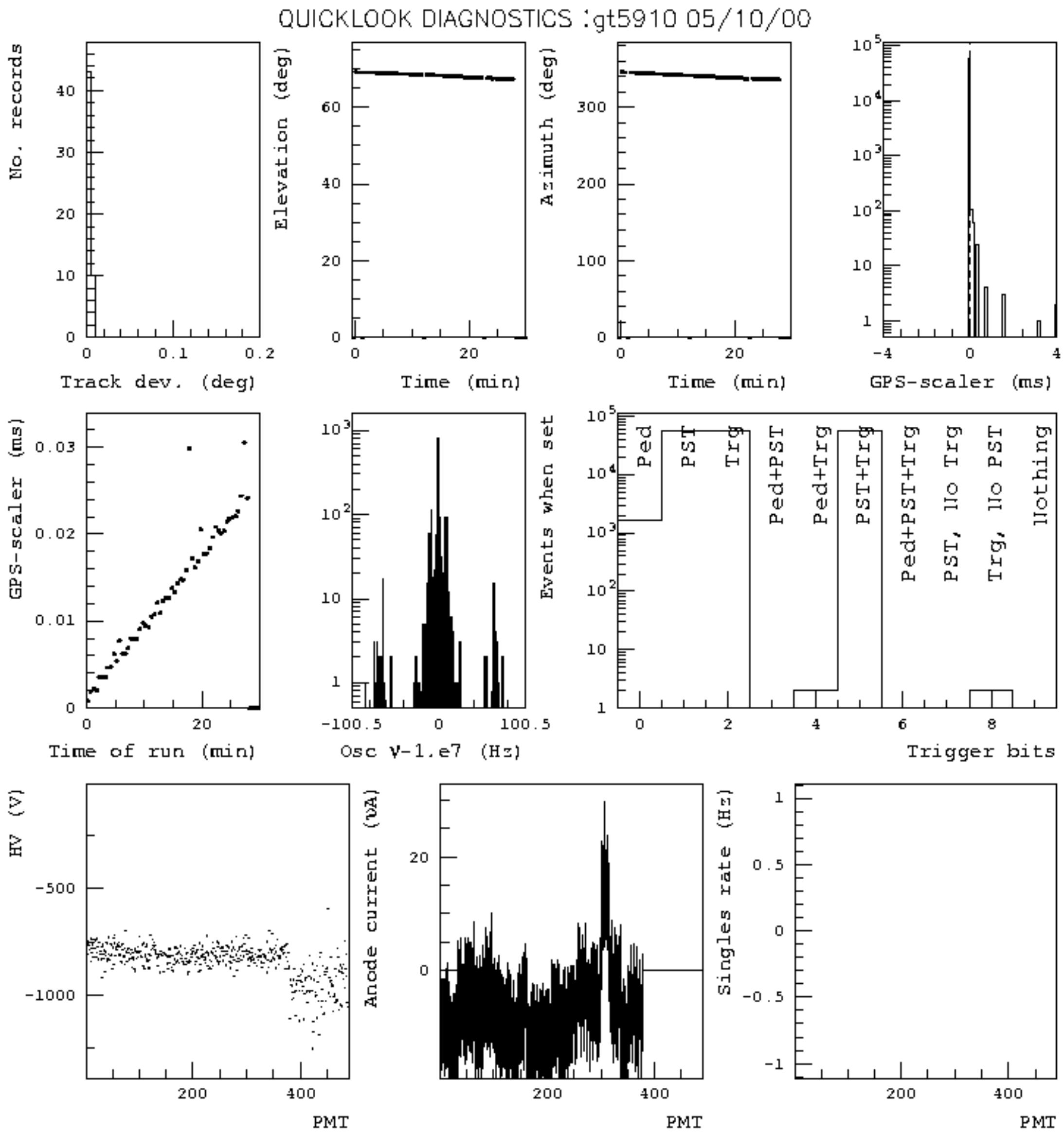

Figure 3.3: `gt5910_dg.ps` – an example of the output postscript file from `diagnostic.kumac`.

  – Make sure no PMTs have excessive currents, indicating perhaps a star in the field of view.

- Singles rate plot - this is the right plot in the bottom row. It shows the mean singles rate for each PMT and the error bars indicate the variance of the singles rate for the run.
  – Look for PMTs with high singles rates. They may have HV set too high or other problems.

alpha_gtnnnnx1.eps This plot is generated by `alphatot.kumac` using the ntuple file containing the parameter values for the events in the run. It shows the analysis results for the individual run `nnnn`.

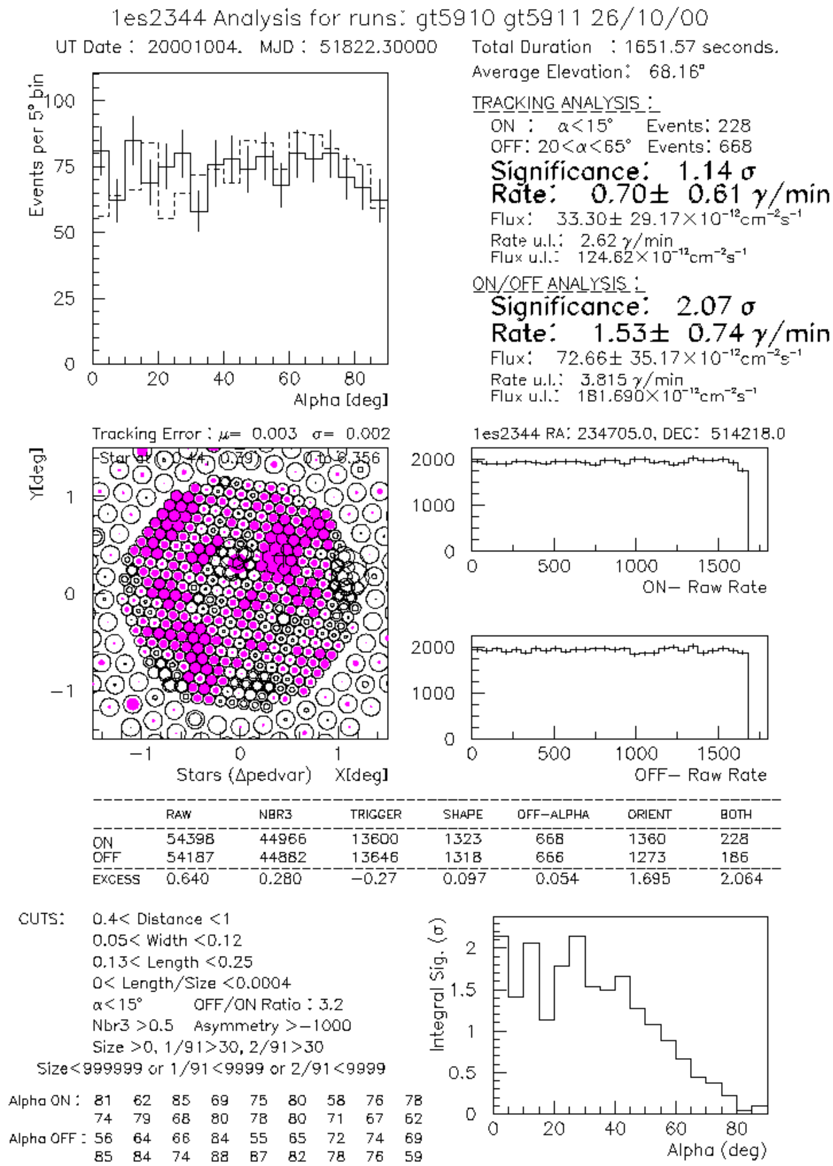

Figure 3.4: `alpha_gt5910x1.eps` – an example of the individual *On/Off* pair output from alphatot.kumac.

An example of this plot for an On/Off pair is shown in Figure 3.4.

What to look for in this figure:

- The histogram in the upper left of the figure is the alpha plot for the run. For *On/Off* pairs, the *On* run is solid and the *Off* is dashed. For *Tracking* runs, only the *On* run is shown. Your hope is to see a large excess in the first 2 or 3 bins of the plot, if it is a point source. The *On/Off* pair should show a close agreement in counts in the off-source region between 20° and 65°. If not, it may indicate that the padding was not done properly, or that the weather changed significantly between runs.

- The collection of text in the upper right side of the figure show the results of the analysis. The `Total Duration` is the live time for the pair (minimum live time of the two runs) or tracking run. The 1680 seconds is 28 minutes so this number should be close to that if the run was 28 minutes long. For *On/Off* pairs, use the `ON/OFF ANALYSIS` to get the significance and rate for the excess. The `TRACKING ANALYSIS` should give a similar rate if the tracking ratio is close to correct (the tracking significance will be higher in general for sources because the background estimate has less uncertainty). The `TRACKING ANALYSIS` lists the region which is used for on-source ($\alpha < 15°$) the region used for background estimates ($\alpha = 20° - 65°$), the significance and rate (if the excess is positive).
- The plot in the middle left of the figure shows the differences in pedestal variances for the *On* and *Off* runs. For *Tracking* runs, a flat-field template is subtracted off for comparison purposes. A large pedestal variance difference indicates the presence of a star in the field (you should know about it already). If the star is in the on-source field, it will show up as a filled circle. If the star is in the off-source field it will show up as an open circle. The image should be derotated so if the PMT coordinates are correct and you know where the star should be in the field, you can use this plot as a rough check of pointing accuracy.
- The two plots in the middle right of the figure show the event rates, in counts/minute, as a function of time of the run. These should both be relatively flat and at similar rates. If not, these runs may not be suitable to use in an *On/Off* analysis.
- The table beneath the above plots (with column headings `RAW`, etc.) lists the number of events passing various classes of cuts for the *On* and *Off* runs as well as the significance of the difference between the two. `RAW` indicates the number of events in the run, `NB3` indicates the number of events which have at least three adjacent PMTs in the image with signals $> 2.25\sigma$ above the pedestal for that PMT (σ is the pedestal variance for the PMT), `TRIGGER` indicates the number of events passing the `NB3` cut, and cuts on max1, max2, and size, `SHAPE` indicates the number of events passing `TRIGGER` and length, width, and distance cuts, `OFF-ALPHA` indicates the number of events passing `TRIGGER` and `SHAPE` but having alpha values consistent with being off-source (20° – 65°), `ORIENT` indicates the number of events passing `TRIGGER` and also α, distance and asymmetry, and `BOTH` indicates the number of events passing all cuts. `TRIGGER` and `OFF-ALPHA` should show a close match between *On* and *Off* run: $> 3\sigma$ difference (positive or negative) should be cause for concern.
- The text below the above table in the lower left hand corner of the figure lists the cuts used in the analysis (make sure they are what you think they should be), the numbers of events for each bin in the alpha plot for the *On* and *Off* run, and the number used to convert the background counts to a background estimate, 3.2, for the current camera.
- The plot in the lower right hand corner of the figure shows the integral significance for the on/off pair as a function of α. This plot is not done for tracking runs. Large ($> 2\sigma$) changes in this plot at large α may be a cause for concern, especially if it happens consistently for different pairs.

alpha_total.eps This is the last plot shown in the *Quicklook*. It is generated by `alphatot.kumac` from the parameter ntuple file and shows the summed analysis for all the runs listed in the command file used to start the quicklook. An example of this output is shown in Figure 3.5 below. Its contents

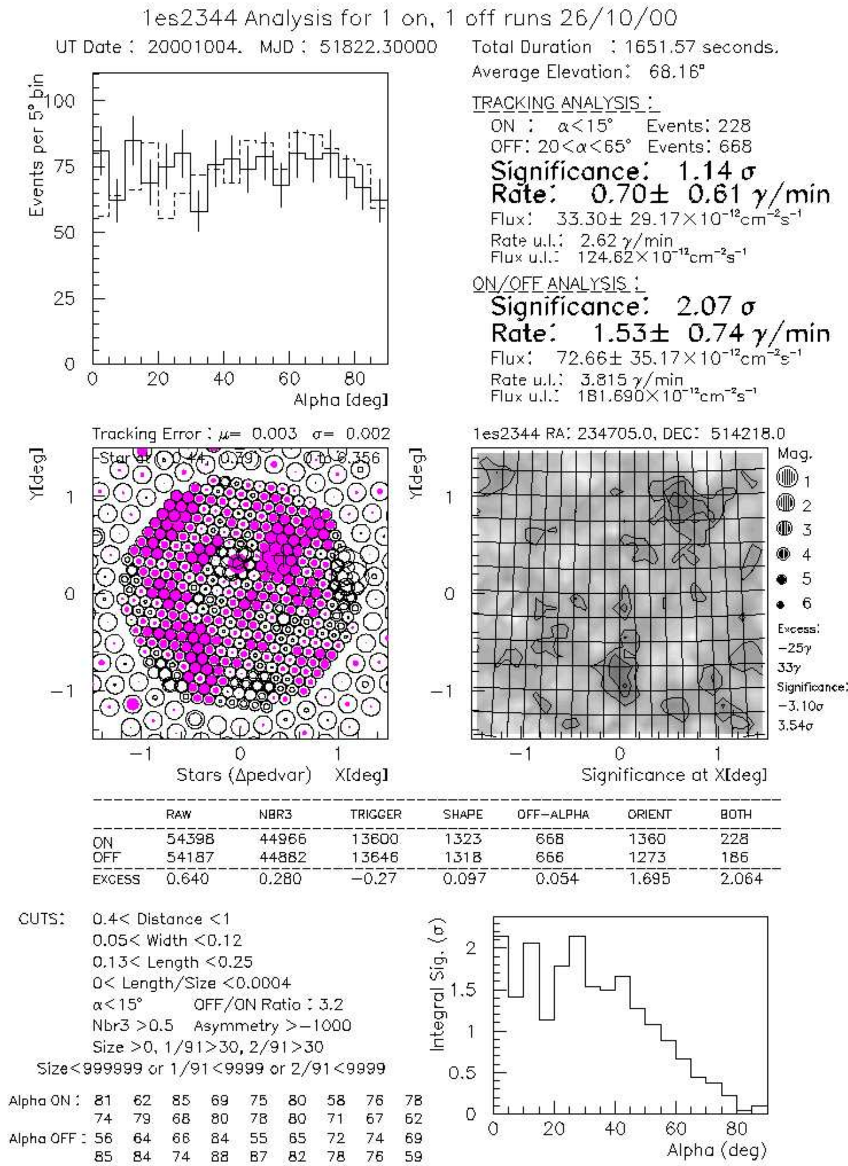

Figure 3.5: `alpha_total.eps` – an example of the summed output from `alphatot.kumac`.

are nearly identical to those of `alpha_gtnnnnnx1.eps` except that it shows a 2-D map of excesses in the camera field of view. If the 2-D analysis is working, it will show a significant excess (indicated by the darker regions) at possible point source locations anywhere in the field of view. The numbers on the right of the 2-D figure indicate the minimum and maximum number of excess γ-rays in the image (-25γ to 33γ) and the minimum and maximum significance (-3.10σ to 3.54σ). Because this grid has at least 900 bins in it (bins are $0.1^\circ \times 0.1^\circ$), 3σ excesses are expected in a plot just from fluctuations of the background. Still, keep an eye on those in case they start to add up.

```
PAWtab.out

Cuts:
0.400 < distance < 1.000
0.050 < width < 0.120
0.130 < length < 0.250
Size >     0., 1/91 >  30.,  2/91 >  30.
Size < 999999. or 1/91 <   9999. or  2/91 <   9999.
Nbr3 > 0.5
Alpha <  15.00 degrees.


-------------------------------------------------------------------------------
             Raw       Nbr3      Trigger     Shape   Sh2090   Orient   Gammas
-------------------------------------------------------------------------------
gt5910.rz    54398     44966      13600      1323      668     1360      228
gt5911.rz    54187     44882      13646      1318      666     1273      186
Excess        0.64      0.28      -0.28      0.10     0.05     1.70     2.06
ON duration:  1652.581    OFF duration:  1651.566    Both cut to:  1651.566
-------------------------------------------------------------------------------
Total ON     54398     44966      13600      1323      668     1360      228
Total OFF    54187     44882      13646      1318      666     1273      186
Excess        0.64      0.28      -0.28      0.10     0.05     1.70     2.06
Total ON duration:  1652.581  Total OFF duration:  1651.566  Cut to:  1651.566
```

Figure 3.6: An example of the file `pawtab.out` produced by `alphatot.kumac`.

pawtab.out This file is produced by `alphatot.kumac` from the parameter ntuple. It contains in ascii format the same information for each run that is listed in the table in `alpha_gtnnnnx1.eps` along with a summed table identical to the one in `alpha_total.eps`. An example is given in Figure 3.6 below.

3.3 Some simple modifications to default *Quicklook* parameters

The default quicklook analysis is optimized to look for point sources with spectra that extend up to a few TeV at least. It also assumes that it obtains certain information from the data files, unless you supply it. So, you may on occasion want to change some of these defaults, or supply additional information to the *Quicklook* to improve its analysis. The instructions below give some examples of how to change some of the defaults for the *Quicklook*.

Changing the parameter cuts: This is probably the most common change people like to make. You may want to do this for low elevation data or a source you expect to have a cut-off (and so only produce low energy events). The cuts for the alpha analysis must be changed in `alphatot.kumac` and do not require a re-reduction of the data. If you want to change the default cuts for the 2-D analysis (not really recommended) you need to change the cuts in `dat.config` and re-reduce the data from scratch. The explicit directions for only the `alphatot.kumac` case is given below.

- *Alpha analysis cut changes:* These are set in the file `alphatot.kumac`. If you want to edit them, do not delete the file at the end of the analysis when it asks if you want to. Then, to set the cuts, just edit the file with your favorite editor. Some cuts you might want to change are listed below. Just find the line in `alphatot.kumac` which begins with `vec/cre cutname` (this creates the vector representing the cut). These are all near the beginning of `alphatot.kumac`.

- `alpha`: You might wish to change this between 10° or 15°.
- `max1, max2`: These specify an upper and lower bound on the max1 and max2 parameters. The lower bound is used as a logical "and", that is if it fails this, the event will not pass cuts. The upper bound is used as a logical "or", so that if it passes any upper bound among the size or trigger cuts, it will be kept (unless it fails a shape or orientation cut).
- `size`: The values entered here specify the lower and upper bounds on size for the analysis. The bounds are used just as in `max1` and `max2`.
- `length`: This specifies the upper and lower bound for the length parameter. The upper and lower bound are both used as logical "and" operators - as they are with any parameter besides the size and trigger ones.
- `width`: This specifies the upper and lower bound for the width parameter.
- `dist`: This specifies the upper and lower bound for the distance parameter.
- `asymm`: This specifies the lower bound on the asymmetry parameter. Using -1000.0 turns it off. The usual cut is 0.0 if you want to apply it.
- `lot`: This specifies the upper and lower bound for the length/size parameter. This can be a useful cut when looking at small events.
- `roffon`: This number, called the "tracking ratio," is divided into the off-source tracking background counts to convert them into a background estimate. You will need to change this number if you change the `offal` value below. This parameter is derived from many *On/Off* pairs over the course of a season for a specific camera.
- `offal`: The region of the on-source alpha plot used for estimating the background in a TRACKING analysis.

Supplying the source coordinates You will probably want to do this if the tracking information is not being written to the data file due to some problem. If this information is not provided, the 2-D analysis will not correctly de-rotate the camera properly to account for a source's motion across the camera. If you want to supply these simply add the following lines to the command file you supply for `analyze`:

```
RA hhmmss.s
DEC +ddmmss.s
```

The coordinates should be as close to the current epoch as possible.

Chapter 4

GRB: Gamma-Ray Bursts

NOTE: GRB observations take priority over all other observations including multi-wavelength campaigns. Alerts should be acted upon as quickly as possible. Because of this, you should make sure to familiarise yourself with procedure in light of a GRB alert being received.

The GRB alert software, *grbalert* is currently maintained by Conor Dowdall at UCD. It is run on *draco* in the 10m building.

4.1 Alert Sequence

1. An audible alert will sound saying "GRB alert, GRB alert"
2. A GUI will pop up with information relating to the burst. This popup will contain an elevation plot for the GRB. An example of the GUI and some instructions are pinned to the notice board beside the door into the electronics room (above the CCD display monitor).
3. The burst's coordinates will be copied to *track10*, and the GRB can be selected by selecting the source directory called *sources.trk.GRB* — as opposed to, say, *sources.trk.primary*.

4.2 What To Do When An Alert Is Received

- Check the elevation plot in the GUI to make sure the GRB is:
  1. Above 17° in elevation and **rising** OR
  2. Above 20° in elevation if **setting**
  3. Less than **3 hours** old
- Stop any runs on *GRANITE* immediately. Exit *GRANITE* and restart the program **r granite**.
- Go to the tracking program and load the file sources.trk.GRB, which contains the coordinates of the most recent GRB notification. Select the GRB entry.
- Start taking tracking data on the GRB source position. You should track the GRB for **up to 3 hours** or until it goes below $\tilde{1}7°$ in elevation.

Note: If an alert comes in from Swift's BAT, a subsequent alert from Swift's XRT (more accurate) might come in soon after. Fortunately Swift BAT notifications generally have a 90% containment of 3 arc minutes, so it would not be necessary to repoint the telescope as this is less than our pixel size. If, however, the XRT alert came in before you started taking data, you should use the XRT coordinates.

4.3 Software

- Every night, **before** observing, make sure that the software is running. This can be done in any terminal by typing `ps aux | grep grbalert`. You should see a line like the following, as a result:

  ```
  observer 6016 99.6  0.0  3160  524 pts/3 R Jun06 9873:43 grbalert 5208
  observer 1824  0.0  0.0  4052  628 pts/5 S 18:00    0:00 grep grbalert
  ```

  If you don't see the first line as above (*ie* only the second line appears on it's own), then you need to restart the GRB software by typing *grbalert* in any terminal. It will take a while for the terminal to say `server():  the server is up`.

- If you ever have to kill the software, you must leave it a while ($\tilde{1}0$ mins or so) before you restart it. Otherwise a lot of **bind()** errors will appear. This is an indication that you should kill the software again and wait.

- If you do ever see **bind()** errors, or have any other reason to stop the program, then kill the software using `Ctrl-C` or by using `ps aux | grep grbalert` to find the process number (PID) and then `kill -9 PID`.

Chapter 5

The Hardware

5.1 LeCroy High Voltage Supply

This series of high voltage supplies, located on the telescope, are largely programmable and can be completely computer controlled. Below are some general instructions on operating these supplies.

Each supply crate controls 16 slots with each slot having 12 channels.

5.1.1 Turning the HV On and Off

The high voltages should not be turned on until either the moon is down (or nearly down), or it is less than 10 minutes before the sun is 18° below the horizon. Similarly, the high voltage should be turned OFF no later than 10 minutes after the sun is past 18° below the horizon, or the moon has risen. These times can be determined from the observers calender or the program *xephem* on *track10* (see Appendix B).

Whenever the high voltage is on, the Gamma-Ray Warning Light must be on as well. This light is located on the dormitory side of the 10m building and is turned on from inside the storage area of the 10m building.

The high voltage supplies themselves are usually turned off except when in use. To turn on the high voltage supplies, switch on the mount power with the breaker switch (behind the door to in the electronics room) and then flip the switch for the tracking interface. The `HV` to the tubes can be turned on by using the `HV` program.

To turn the High Voltages ON

(1) Ensure the mount power and tracking interface are on and you have waited a minute or two for the ethernet connection to the HV crates to come alive.

(2) Start the `HV` program on the tracking computer by typing **hv**, or **hv –cmonitor offline** (to start without the broken current monitor) at a *track10* prompt. Next click the **HV ON** button at the top right of the program window. See Figure 2.1.

(3) Start the current monitor program by left-clicking on the **Display** pull down menu and then left-clicking on **Anode Current**. If anode current view is selected when the HV program is started with current monitor enabled, it will crash the program. This is why it is a good idea to use the **–cmonitor offline** option.

Check that all tubes are on and operating normally. Problem tubes may be left off for a reason. If you see several tubes off, please check with a local observer to see if they should be turned back on.

Tubes 390 to 490 don't have current monitors, so don't expect anode currents other than zero. The tubes are also color coded based on their anode current value and the color scale at the top left of the display window. (**NOTE**: This aspect of the HV program does not currently work. It was damaged, probably due to a lightning strike, at the beginning of the 2006-07 season).

To Turn the High Voltages OFF

(1) Hit the **HV ON** button in the `HV` program located on the top right side of the window so that the circle is red in color. See Figure 2.1.

(2) In an emergency, use the **RAMP OFF** button on the HV box beside the door to the electronics room. When turning back on the HV, remember to turn off the `RAMP OFF` switch. If for some reason the `RAMP OFF` switch does not work, flip the switch for the Tracking Interface and the Mount Power.

NOTE: The IP addresses for the HV crates are as follows:

```
192.33.141.32
192.33.141.34
```

5.1.2 HV problems

HV settings

The next most frequent problem with the HV supplies is that their voltage settings get changed by an observer. The solution is straightforward. Left-click the **File** pull-down menu and select **Load Voltages** (see Figure 2.1). Select and load the appropriate voltages for the observing schedule, usually *hv.settings* which is a symbolic link to the most recent file. Finally, check the singles rates (see §2.8.3) for the tubes to make sure they are reasonable. High or low rates could indicate an error in the HV value. If the singles rates plot doesn't appear to be functional, use *Quicklook* to analyze a laser file and use the troubleshooting plots and graphs generated.

5.2 The Telescope

The telescope drive may be controlled either manually or by the *track10* telescope PC program.

5.2.1 Power

The power for the telescope drive passes through a switch located on the wall of the `electronics` room and is a large blade-type switch labelled **Mount Power** which must be in the **ON** position. Another switch which must also be turned on is the located on the **Tracking Interface** panel which resides in the first rack in the electronics room .

5.2.2 Warnings

The cable wrap limit on the telescope prevents it from rotating more than 270° in either direction from north, but hitting this limit is to be avoided as it can be very messy to reset the drive. Similarly, there is a limit in elevation a bit over 90°. Hitting this limit should also be avoided.

5.2.3 Manual Control

The manual controls for the telescope are located on the tracking controller in the electronics room. This must also be powered in order for the telescope to move. There are 2 displays, one for azimuth (0–360°) and the other for elevation (0–90°). There are `Auto/Manual` switches for each of these drives which need to be set for **computer/manual** control, respectively. There are also `Enable/Disable` switches for each of these drives. Disable prevents the telescope moving either under manual or computer control. So these switches should be in the **Enable** position.

To move the telescope manually in either azimuth or elevation, first exit the tracking program. Recycle the power to the tracking controller (leaving it off for several seconds). Ensure the switches are set to **Manual** and **Enable**. The speed control dials may be moved until the required speed is achieved. Turning the controls clockwise from 0 increases the elevation or azimuth and counter-clockwise decreases them. The controls should be returned to zero when the required pointing direction is achieved.

The telescope is visible from the electronics room and should be continually checked for obstructions etc. when under manual control, if it is not dark. If it is dark, have one observer at the controls with a portable telephone and the other one outside with the other portable phone to guide him/her. NEVER LEAVE THE MANUAL CONTROLS if moving the telescope manually.

The position of the telescope may be verified using the program *follow* on *track10*. Login to *track10* as *observer* with password from Appendix D, if not already logged in. Type **follow** in an xterm window. The *follow* program will display the telescope position as well as several limit and status lights.

5.2.4 The Tracking Computer

The telescope PC, *track10*, is a much more convenient method for controlling the telescope motion, especially when attempting to track objects. To use computer control, the drive settings on the tracking controller must both be set to **Auto** and **Enable**.

Starting up the computer control

Log in as *observer* on *track10* using the password from Appendix D, then enter **track** at the prompt in an xterm. This will start the tracking program.

Once the program is started, it is first necessary to ensure the PC clock is accurate so that the conversion from right ascension/declination to altitude/azimuth is correct. If the PC clock is within 4 seconds of the GPS clock, it is good enough. If the time difference is greater than that, set the clock according to the instructions in §5.2.5.

Once the time has been set correctly, the standard menu is displayed. See §2.8.2 for instructions on how to choose a source.

Turning off the computer control

Once tracking has been finished for the night, and the telescope is stowed, the tracking program should be exited by choosing the **EXIT** option from the **COMMAND** button in the tracking program. See Figure 2.1.

Telescope control options

In the tracking program a menu displays the options which are available for the observer. They, along with a brief description are listed below. All of these options can be done with the mouse in the tracking program by clicking on the appropriate buttons as shown in Figure 2.1.

Continuous Tracking To select a source click on the source name (e.g. VZW331 in Figure 2.1). A window will pop up to ask you if you want to choose a source from a list, a burst source, or change the name of the existing source. Click on the button labelled **LIST**. Select a list file (usually **sources.full.trk.00**). Use the browser bar to scroll down to the desired source and click on it with the mouse. Sources highlighted in white are setting in the local sky, those highlighted in blue are rising, and those highlighted in black are below the horizon. This will update the main tracking window to show the newly selected object. When this is repeated a window will appear asking whether to use the same list file again. Entering **Yes** will bring up in list of sources and **No** will allow you to choose another list file.

Start tracking by clicking the **STANDBY** button. This will set the telescope in motion and the *STANDBY* button will read **TRACKING** (see Figure 2.1). To stop the tracking just click on the **TRACKING** button. There is a *TRACK ERROR* window that will give the distance between the telescope and object (in red when the distance is greater than 0.22°).

On/Off Tracking Choose a source as described above. Click on the **OFFSET** button if you want to select a different on/off duty cycle (default is 30 minutes). Next, click on the **ON-OFF** button, if you want to select the *OFF* before *ON* mode (default in on before off). Click on the **STANDBY** button to start the tracking and wait until the telescope is on the source before taking data. Click on the **ON Source** or **OFF Source** buttons to move between positions. See Figure 2.1.

Pointing Check While the telescope is on a source and tracking, click on the **COMMANDS** button and then select**POINTING CHECK**. The telescope will slew off to a designated star for that particular source. If the telescope does not move to the pointing check star try clicking the button again. If the telescope still will not move then there is either no pointing star for that source or the telescope drive is disabled (see §5.2.5). Monitor the tube currents using the High Voltage program. Click on the **DISPLAY** pull-down menu and then select **POINTING CHECK** to obtain the currents in the first 7 tubes. Write these down along with the UTC, AZ, and El. Enter these values in the *LOG FILE* in the corrct spot. Press **P** to return to the original source. See Figure 2.1.

Moving to a specified point in the sky With the tracking in the *STANDBY* mode click on either the **AZ** or **EL** position indicators. Enter the desired azimuth and elevation when prompted. The telescope will move to these coordinates after the elevation is entered. To stop the telescope while moving to a position, press **S** on the keyboard. See Figure 2.1.

Moving to a specified RA and DEC With the tracking in the *STANDBY* mode click on either the **RA** or **DEC** position indicators. Enter the desired RA and DEC when prompted. The telescope will move to these coordinates after the declination is entered. To stop the telescope while moving to a position, press **S** on the keyboard. See Figure 2.1.

Moving to the Zenith With the tracking in the *STANDBY* mode, click the **COMMANDS** button and select **ZENITH**. The telescope treats this as a position so **S** will stop it moving. You may also enter an elevation manually as described above. It is often better to go to 89° rather than 90° to avoid hitting the limit switch. See Figure 2.1.

Stowing the telescope With the tracking in the *STANDBY* mode, click the **COMMANDS** button and select **MOVE HOME**. Again, the telescope treats this as a position so **S** will stop it moving. The telescope will move all the way to zero azimuth and then down to zero in elevation. See Figure 2.1.

Tracking the Moon This is left over from a previous experiment. The moon must be up to try this or the program will crash! With the tracking in the *STANDBY* mode, click the **COMMANDS** button and select **TRACK MOON**. A few seconds will pass as the program calaulates the moon's RA and DEC for many siderial times then a second tracking window will appear. To track the center of the moon click on the center button then click on the **STANDBY** button. To track any of the four optional positions around the moon (28 mrads from the moon) just click on the desired button on the moon window. See Figure 2.1.

Telescope display

The program will display **SLEWING** until it is pointing within 0.2° of the source. It will then display **TRACKING**. See Figure 2.1.

5.2.5 Telescope problems

The Telescope won't move: El/Az (or both!) position values jump around

This problem was remedied in 2006 by changing some old 9-line ribbon cables in the mount. They connected from a strip connector on the roof of the mount to a box on the left-hand side as you look in the main door. There is one ribbon cable each for azimuth and elevation. One end has a female DB-9 connector and the other has bare wires which connect into the strip connector by being screwed into place.

Although we seem to have found a more permanent solution to this, the common (intermittent) problem a few years ago would see the encoder values jump sporadically to El = -10.251° and Az = 90.371° (or some other similarly strange value). These values are typically indicative of a communication breakdown somewhere between the encoders and the interface in the Control Room.

In the case of elevation, it would manifest itself in the telescope freezing and an error appearing on the screen saying that the telescope was at a negative elevation and is being stopped for safety reasons. This meant that the program could not be used to control the telescope any more.

If this happens don't panic and start phoning people, unless the telescope is in real jeopardy and you are unsure of what you are doing; there may be a simple solution. Try the follwing steps in this order:

- Turn off HV
- Power down tracking interface in the rack
- Power down main mount power switch (on wall)
- Check telescope pointing by going outside
- Kill tracking program on *track10*. You may have do this in the teminal by killing the process if the interface is already powered down. This step is necessary in order to control the telescope manually using the interface control.
- Switch tracking interface to "Manual" and "Enable"
- Look at the back of the rack for obvious cable problems. Try not to disturb these cables too much if possible
- Turn on main mount power
- Turn on tracking interface

- If the display is now returned to its proper coordinates you are, more than likely, back in business. If not, you should try to move the telescope, under manual control, back to a stow position. Have someone stand outside and watch the telescope move as you have no visual reference. Turn the El/Az knobs slowly to increase speed. If the display flashes “DISABLE”, then turn the knob back to its zero position and start again.

- Try the tracking emergency program to check if it is working. On *track10*, go to **/home/observer/src/EMERGENCY/v3.0/emergency**
  If it works, this will move the telescope very slowly; so slowly that it will not be apparent.

- If this fails, you should start thinking about who to contact for help, especially if it is getting close to sunrise. There will probably be someone at VERITAS who can drive up from basecamp and help you in an emergency (REMEMBER: It will take 30mins for them to drive up, so make the call in good time if you think you need to.). If you simply need a hand with something, you should also consider the 60” observer, or there may be someone in the dorms.

- Once you have help, you should take out the laptop, labeled **EMERGENCY LAPTOP**, located on the shelves beside the UPS/optics room. Inside is a laptop and special interface cable. There are step-by-step instructions and photographs showing how to bring the telescope home manually out at the mount. This should be a last resort.

The urgency of the problem depends on the position of the telescope. The sun cannot come within 60° of the optic axis of the telescope without causing damage. The initial problem zone will be the base of the quadrapode arm farthest from the sun, where cables will begin to overheat. Try to replace the cover if you can, although you shouldn’t dwell on this if time is a big factor.

A safe position is anywhere near stow. If you can’t get to stow, close (or even relatively safe - eg west) will do. If you can’t get to a safe position, you should contact one of the following people, irrespective of the hour:
Trevor Weekes
Ken Gibbs
Other local staff

The telescope will not move

First check that the mount power and tracking controller are on (see §5.2.1). If they are, then try manually moving the telescope in `ELEV` to see if the telescope will start to move (see §5.2.3). If this does not fix the problem then it is likely that a fuse is blown in the telescope drive. These fuses are located in the telescope drive itself and are accessed by unbolting the metal panels on the side of the drive. The control boxes are inside the mount. Get help changing the fuses if you have never done this before.

The Track program gives message ”Move telescope up above 1-4 range”

This will occur if you start the tracking program when the telescope is at an elevation with the first digit to the left of the decimal place in the 1-3 range (*eg.*, 21.3 or 42.5). This is a safety precaution to keep the telescope control from moving a telescope down when it is not sure where the telescope really is. To correct this problem, simply move the telescope manually out of this elevation range. The computer should recover and understand where the telescope really is pointed.

Emergency Telescope Storage

This procedure is only used to stow the telescope when the procedures described above have failed. They are opoerative when there has been a failure of the tracking computer or serial fibre connections **AND** manual control failure. This procedure describes how to use the Emergency Dell Laptop at the mount (north door, near the OSS when telescope at stow). You must still have power at the mount. The laptop's software is teh same as the emergency routines found on the main tracking computer.

- **Laptop Location:** The laptop is stored on the wire shelving beside the door to the UPS/optics room (behind you as you sit at *track10*). It is in a clearly labeled (**EMERGENCY LAPTOP**) black laptop bag. It should be checked regularly to make sure it is fully charged.
- There is a set of laminated, easy-to-follow instructions, with diagrams and photos showing where everything is, in the laptop bag with the laptop.

1. Boot laptop to Linux (RH6.2) by powering up and hitting *return* at boot prompt.
2. Log in as **observer**, using password [redacted]
3. Open the **north door** of the mount. This is a door which will be right next to the OSS if the telescope were stowed. Put the laptop in a secure position.
4. Inside the door, there are **two** serial ports on the motor controller — one for elevation and one for azimuth. You will have to connect the laptop to one of the serial ports using the cable inside the laptop bag. NOTE: You can only control azimuth or elevation at any one time, but not both at once. **Only use the cable provided, as any standard serial cable will cause fuses to blow.** There are spares in the unit if this should happen.
5. Be very careful not to touch off the RED power cables as you work at this — they can shock you!
6. Make sure there is power going to the controller. If the mount power is on, this should be the case. If there is no pwer to the mount, the problem could be the fuse in the control room. If that is okay, then there could be a problem with the manual electronics. If this is the case, it is still possible to get power by jumping the power relay*. NOTE: This is non-trivial, but is explained below.
7. On the laptop, log into the observer account if you haven't done so (password: [redacted]). If you have to start X-windows, type `startx` at the prompt. Open an `xterm` window by clicking on the desktop and selecting `xterm` from the menu.
8. Do the following:

   ```
   \$ cd /home/observer/src/EMERGENCY/v3.0
   \$ ./emergency
   ```

   Some alert windows will pop up. Click `Dismiss` for these. You will get a window asking you to choose the AZ controller or the EL controller. Select the **one** which you are connected to. NB: The program gives you the option to control both motors at once, but this **does not work**.
9. In the main window, select which direction you wish to move in. The slew rate will only be 10° per minute (slow), so check where you want it to go. Press `STOP` to stop moving. If limit switches are a problem, they can be disabled, but this should only be done as a last resort.

10. Move the telescope in azimuth to around 0°. Then move it low enough in elevation to replace the cover.
11. Select `QUIT` to exit the program. You will get serial port timeouts when you quit, but this is fine.

NOTE: To jump the relay box in the mount

Do not attemp this unless you really know what you are doing. Locate the relay box in the mount and open it. The large relay in the lower central area is the power relay. At the top of the relay are two leads which control the relay. One lead goes to ground at the frame of the power supply on the right. The second lead is the one which must be jumped. Open the breaker box (to the right) and turn off the lower left two breakers (AZ and EL controller power). Now place a jumper lead on one of the large red leads at the top of the power relay and the second relay control lead (**NOT** the one that goes to ground). Turn the two breakers back on and you should have power.

The *track10* clock is incorrect

Log on to *track10* as super user (type *su* from an *observer* window and use the password from Appendix D. Enter the command **date MMDDhhmmYYYY.ss** where *MM* is the month, *DD* is the day, *hh* is the hour, *mm* is the minute, *YYYY* is the year, and *ss* is the seconds. Time is local time (UT - 7 hours). Then type **/sbin/clock -w**. The tracking computer must then be rebooted for this to take effect. As superuser type **/sbin/shutdown -r now**.

The CW/CCW button screen pops up on *track10*

There is a switch on the mount, located between the two counterweights that the telescope automatically uses to determine which direction it has moved (clockwise or counterclockwise). The telescope must know this to prevent it from hitting an azimuth limit switch. Occassionally (recently, more often, when the telescope is at exactly 90° elevation) during automatic operation, this switch may be hit more that once. The telescope will think it has moved in the opposite direction if this is allowed to continue. If this happens the telescope stops and a screen will pop up on *track10* to tell the observer to manually press the switch and so reset the direction the telescope thinks it has moved. DO NOT press **DISMISS** until you have pressed the switch and returned inside. Before going outside, turn off the high voltage. If the telescope is near the zenith, the switch can be reached by climbing on the mount. The step ladder is required, otherwise. The switch is located between the counterweights, about 5 feet above the concrete pillar. It is hidden by a small metal plate. The switch is made of two small wheels connected together. Press the right hand side once until it clicks (this is the only way it can be used anyhow). Move the ladder back, out of the way of the telescope, if needed. Press **DISMISS** on the screen on *track10* and then press **STANDBY**. The telescope should start to move again. It is now safe to turn back on the high voltage.

5.3 *Taurus*

Taurus is an DEC ALPHA Computer. It is used for the acquisition of data from the 10m telescope. It runs under the VMS operating system.

5.3.1 Defining a new display

To display the windows on a different terminal, the following command needs to be typed in the current window: **set display/create/transport=tcpip/node=** *display_name*.

This command is analogous to the `setenv DISPLAY` command in UNIX with the exception that `display_name` does not have a `:0.0` after it.

5.3.2 File Locations, Directory Structure

The data acquisition software source codes are stored in the following directories. These definitions point to different places if the the account was set up to use the developmental version of the data acquisition software.

The general structure of the directories is *USR1:[OBSERVER.NAME1.NAME2]* where *NAME1* refers to the program name (*e.g.*, *GRC*) and *NAME2* refers to the version (*e.g.*, *V### or VDEV*). To change directories enter the command `set def DIR$NAME`.

The definitions set up by the *ACQUISITION* account are:

Definition	Program Name
DIR$PRO	*GRANITE* Programs

Other definitions are:

Definition	Directory
DIR$COM	Command files for setting up various options
DIR$DATA	Data Directory (USR2:[OBSERVER])
DIR$GDF	*GRANITE* Data Format
DIR$VDEV	Development Programs

To see the actual directory defined by these aliases use the command **SHOW LOGICAL** *NAME* where *NAME* is the name of the alias.

5.4 Laser Pulser

A new flat-fielding system was implemented on 16 May 2007. A laser diffuser was fixed on the centre of the reflector facing the PMT camera. A fiber optic was laid underground to connect the diffuser with the laser pulser (see Fig 1) which is inside the 10m building in the UPS/optics room (see Figure 2.2). Prior to the laser being installed, a nitrogen arc lamp pulser was used.

CAUTION: Do not uncover the laser apparatus when it is powered on. The laser operates at a wavelength and power that can damage your eyes. **BE CAREFUL!**

Fig 1: Schematic

5.4.1 Pulser Operation

The diffuser (at the centre of the OSS) illuminates the front of the camera uniformly and is used to determine the relative gains of the PMTs. The mean ADC values for the PMTs are recorded and used to calculate the relative gains offline in software.

The laser is currently set to a frequency of **32 Hz**. This can be changed using the `Repetion Rate` botton on the control panel of the device (see Fig 2).

Fig 2: Laser pulser

5.4.2 Laser Run

The laser calibration runs can be performed at any elevation but no bright stars should not be in the field of view. It is a better idea to take this run at an elevation of 0° (*stow position*) to reduce background.

To begin a laser run, power it up in the UPS/optics room using the power strip connected to it. Make sure that all the PMTs are turned on (check HV program on *track10*), take a 3 minute run by clicking the TRACK botton in GRANITE. In the event display window on *GRANITE*, make sure that the tubes are recording strong pulses (large circles) from the pulser. The frequency displayed should be similar to the Repetion Rate setting on the laser pulser (*eg* 32 Hz).

Any strange behaviour in the display should be reported in the `LOG FILE`. A low gain could mean the HV is off or low. If this is the case, the voltage on the tube may have to be varied.

REMEMBER: Turn off the laser pulser after the run!

5.4.3 Laser File

The *Quicklook* analysis, run on *draco*, can analyze the laser files in the same way as the old nitrogen files used to be analyzed. The following line should be added to the beginning of the command file when analyzing the night's first data file:

n2 gtmmmmmm utdate

where **mmmmmm** is the run number of the laser file. *"n2"* is used because this was the nomenclature used to analyze nitrogen files in the past. This file need only be analyzed once at the beginning of the night and the line can then be commented out for subsequent runs.

5.5 The Electronics

The two main responsibilities here are to make sure the power is on to all the modules in the four racks and to <u>KEEP THE DOOR CLOSED</u>. This will keep the electronics at a steady and cool temperature. In the winter, it will also allow the observers to turn on the space heaters.

5.5.1 High level discriminator settings

The discriminators determine what voltage level from the PMTs constitutes a real signal which is sent on to the trigger logic. These should be set to approximately the same value for uniform response of the camera to the showers. The constant fraction discriminators are in Rack 2. To check the threshold setting you will need to view the `COMMAND HISTORY` window where *GRANITE* was started. The discriminator settings are echoed in this window as the system loads. If the discriminators are not set properly change them with the command **PRODUCER10/SET/DISC_THRESH 6 -1 -1 A** in the `COMMAND INPUT` window, where `A` is the discriminator setting in millivolts. Enter the value used for the discriminator thresholds in the log file.

5.5.2 Electronics problems

Crate Controllers

If you suspect that there may be a problem with the ethernet CAMAC crate controllers, the following will help in diagnosing the problem. At a `taurus` prompt login as *SYSTEM* by typing **SET HOST 0**. Enter the command **SHOW SYSTEM**. You should have a process running called `ECC_1365`. If you do not, enter the command **ECC/LOAD**. This will load the crate controler software.

5.6 Clocks

There is currently 1 clock in electronics Rack 2, a GPS (LCD display). It should remain powered on at all times.

5.6.1 GPS Clock

This is the main clock used to record the time of events in the runs. It is read out by a Michigan interface module to an accuracy of 1/4 μsec. In principle, it can be accurate to within 100ns, if it is locked. There is really not much to do with this unless it is having problems.

When the GPS is reset (*e.g.*, in the case of a power failure), it reverts to 12 hour mode. In order for event times to be recorded correctly (and the taurus clock set correctly using the `SYNC` command), it must be changed to 24 hour mode. This is achieved through selecting **FUNC 02**, then using the up/down key to change the mode, and then hitting **ENTER**.

To view the list of available functions, select **FUNC 00** and then use the up/down keys to go through the list. The more important functions are listed below.

GPS Function Codes

Function #	Action
00	List All Functions
01	Set Time Zone
02	Toggle 12/24 hour mode
03	Set Current Time
04	RS-232 Port Setup
05	Set Time Quality Flags
06	Lock/Unlock Keypad
07	Select External Oscillator
13	Worst Case Time Error
14	Oscillator Stability
16	Enable Emulation Modes
17	Slow Code Setup
18	Report Software Version
30	Set IEEE Address
31	Backlight ON/OFF
50	Enter Unit's Position
51	Set Cable Delay
53	Set Time/Survey Mode
55	Select feet/meters
60	List Satellites
65	Selects Satellites
66	Daylight Savings Time ON/OFF
71	Show Oscillator Statistics
79	Warm Start

Problems with the GPS clock

If the GPS LCD display is flashing, then the clock is unlocked. To reset the lock on the clock:

(1) Hit the **FUNC** key, followed by **53**.

(2) Hit the ↑ key until `SURVEY` appears on the display.

(3) Hit the **FUNC** key.

This will set the clock searching for a satellite to lock into. To display the current timing error of the clock, select **FUNC 13**.

5.7 CCD Camera

A CCD Camera is mounted next to the PMT Camera, facing the night sky. During the day it should be powered off. Its power is controlled by the **Mount Power** and **Tracking Interface** switches in the electronics room.

During the night, the CCD camera is used to monitor the pointing of the telescope by recording the positions of the brightest light sources at some pre-determined spacing.

It is currently controlled by the PC located in between *taurus* and the tracking computer *track10*.

5.7.1 Basic operating procedure

(1) Ensure cooler is switched on. It is located on top of the first rack. The `Tracking Interface` controller supplies power to the CCD cooler so it must also be on.

(2) Start Windows (**WIN**) at the DOS prompt and double-click on the **STARGAZE** icon. This will automatically power up the CCD.

(3) Check that the UT time and date are correct. If they are not, use the **change UT time** and **change UT date** option and input the correct `UT` time and date (see §5.7.2 number (4)).

5.7.2 For those who wish to know more

Brief instructions for operating the new ccd software:

(1) To start the software, double click on the **Stargaze** icon. If a message appears stating that 'This application attempted to access a device that is being used by another application, etc.', simply hit **Enter** (i.e. respond **Yes** to the question). The system will load up using the same settings (exposure time, etc.) as was used on the previous occasion.

(2) To activate any option, hit the letter which appears as a capital in the option name, eg. to save a dark image, hit '**v**', to view advanced options, hit '**o**' (no need for the shift key). Be patient - depending on the exposure time, it may take several seconds for the system to respond to a request.

(3) Summary of the options presently available:

- Toggles:

  i : display normal/inverted (latter will show black stars on white background)

  a : archiving on/off

  d : dark image subtraction

  p : display position marker (cross-hairs)

  c : display pixel coordinates at corners of image

  r : display 2,4,6 degree rings, centred on position marker

  g : display full (14x10degree) image; default display is 9x9 degrees (in full image display, hit return to return to default display)

  z : toggle interlacing

- Indicators:

  t : change UT time

  u : change UT date

  e : change exposure time

  f : change archiving frequency

  m : change position marker coordinates

- Other options:

  s : save complete image (dark subtracted)

v : save dark image

y : display a saved image

o : go to advanced options menu

- Advanced options:

b : change bias value (like a pedestal)

h : change gain value

w : noise threshold (used in finding stars in archived image)

j : noise range (ditto)

o : return to Other options menu

q : exit from the program.

After using the system for a while, if you have any other options/modifications that you feel would be useful, please note them in the manual.

5.8 PMT Camera

The PMT camera was designed to consist of 490 PMTs (see Figure 2.1). We currently use 379 of these (the inner tubes only) as the outer 2" tubes have been removed. When we are not observing it is covered by a white metal plate which is bolted onto the front to prevent unnecessary exposure of the PMTs to light. This metal plate must be removed before observations can take place and it should be replaced at the end of the night's observations.

5.8.1 Camera display

The *HV* program supports a current monitor which is turned on by left-clicking the **Display** pull-down menu and then selection **Anode Current**, but only do this if the program has been started with the **hv –cmonitor offline** command as the current monitor is not working presently. This display mode will give you faster refesh times however, so it is useful. See Figure 2.1. The tube icons turn dark red when the current in the PMT gets too high. This usually happens because there is a bright star in the field of view. It can also happen if a tube or cable is bad, but that is less frequent. If a tube is red you must check to make sure that the current is not so high that it may damage the tube. To do this, left-click on the circle that represents the tube in the `HV` program. A window will pop up giving the status of that tube. If the anode current is above 60 μA, turn the tube off by clicking the off button at the bottom of that window. All other tubes should be left on. If the run is an *ON/OFF* pair leave the tube off for both runs then turn it back on. If the run is *TRACKING* turn the tube back on when the run is completed.

NOTE: Because the telescope has an altitude-azimuth mount, bright stars will move to different parts of the camera as the night goes on. So you should pay attention to the display to make sure no new tubes appear hot during the data collection. If they do appear, turn them off as needed.

5.9 Power

In the case of a power failure, the computers, and electronics should not lose power. They are connected to a UPS, but this only has a limited lifespan.

If the computers do lose power, they should automatically reboot.

In addition, if the GPS clock loses power, it will need to be reset from 12 to 24 hour mode, and may also need to be set to seek satellites (see §5.6.1).

Chapter 6

Data Acquisition

6.1 Introduction

Data Acquisition is carried out on the DEC ALPHA known as *taurus*. It runs on the VMS operating system. The account used to run the data acquisition system has the name *observer* and password from Appendix D. This account should be logged into before the start of the night's observing.

The *observer* account sets up some aliases and paths for use in running the data acquisition. Directory paths to the various parts of the acquisition code are set up depending on the current version of the acquisition system being used.

6.2 Preliminary Preparations

Before starting the acquisition program some procedures must be completed in order for the system to function properly. The complete list of procedures at the beginning of the night is in §2.1. A few of the more important are listed in the following subsections.

6.2.1 Hardware

Clearly, the electronics should be powered up before turning on the acquisition program. The telescope tracking program should also be started because the acqusition program starts up a *SERVER* task which tries to ftp data from the tracking PC to *taurus*.

You should also make sure there is enough disk space on the data disk to collect the night's data. To check the disk space enter the command: **sh dev dk**. It will list three disks. The two to worry about are the ones with *Volume Label USR1 and USR2*. *USR1* is where the acquisition programs are. Some small files are written there so if it has more than 10,000 *Free Blocks* it is probably enough. *USR2* is where the data is stored. There should be at least 4,000,000 *Free Blocks* there for a full night's observations. If not, old data can be deleted as long as it has been transferred to both *draco* and *egret*. See §6.5.3.

6.2.2 Log file

The `LOG FILE` is the log for the night's observations. It is opened and edited by the night's observers. The template for the `LOG FILE` is shown below and can be found on *veritas* in `/data/log` as *comment_10.txt*. The log files are kept in subdirectories named as follows:

`/data/log/dYYMM/dYYMMDD.log_10`

```
UTDATE  000905  10M LOG
```

ID	RUN	Source	SID	UTC	DUR	MODE	SKY	PNT	El	Az	Hz	Comments
n2	15610	nitrogen	21:58	06:23	1	fixed	C	n	20	270		
vz	15611	vlza	21:59	06:24	10	fixed	C	n	20	270	6.5-8	*
zn	15612	zenith	22:14	06:39	10	drift	B-	n	89	270	20	
3e	15613	1ES2344	22:27	06:52	28	trk	B-	n	65-68	30	19-20	
3e	15614	1ES2344	22:55	07:20	28	trk	B-	n	68-70	22	18-20	
3e	15615	1ES2344	23:23	07:48	28	trk	B-	n	70-	11	12-23	**
vz	15616	vlza	23:56	08:20	10	fixed	C	n	20	270	10-21	***

Observers: TAH, HMB

SKY: C very cloudy at the beginning of the night.
Clouds seems to be cleared overhead, so we change to B-.
Around UT 7:15 lightning east and north close to harizon.
Around UT 8:04 lightning south east.

Comments:

* very unsteady.
* bumpy rate in particulary after 12 min. After 20 min. the rate is going down dark clouds are moving into the field of view. The rate reached min (12Hz) at 25min.

*** Lightning in south east direction continues. We decided to quit for now.

decided to call it quits for the night. the lightning continues and clouds continue to drift through.

Tubes off:

415 and 485 all the night.

Pointing checks:

Source or RA/DEC	UTC	Az	El	1	2	3	4	5	6	7

Discriminator Values (mV):

40mV with 3/331

Quicklook Results:

```
Object       Run     Sigma   Rate(/min)      Comments
------      -----    -----   ------------    --------
VLZA        15611    1.16    0.70+/-0.61
            15616    0.52    0.34+/-0.66
            -----    -----   ------------
            total    1.18    0.53+/-0.45

Zenith      15612    1.06    0.81+/-0.76

1ES2344     15613    1.89    0.93+/-0.49
            15614    1.41    0.67+/-0.48
            15615    0.42    0.17+/-0.41
            -----    -----   ------------
            total    2.22    0.59+/-0.27

note: in the last two nights we have not had a run with a negative
significance.


Zenith Run(s): (relative to gt4420)
--------------
Run    Rate/Hz  Throughput
---    -------  ----------
15612  20       0.992

Data Acquisition Problems
--------------------------
Tonight and last night we noticed the first bin in the max distribution
on granite is high at the begining of the run (~20-40 events). It then does
not change very much and the rest of the distribution catches up.

Engineering:
------------
```

The current UTC date should be entered after `UTDATE`.

The entries under the long row starting with `ID` are run specific entries. `ID` is the two character code for the source which is being observed. `RUN` is the run number. `Source` is the source name. `SID` is the sidereal start time for the run. `UTC` is the universal time for the start of the run. `DUR` is the duration of the run in minutes. `MODE` is the mode for the run (*i.e.*, `TRK` for tracking runs, `ON` for on runs, and `OFF` for off runs). `SKY` is the current sky quality (A for good, B for medium, C for poor) and any other relevant weather information (see Appendix A). `TUBES OFF` should list tubes turned off for the whole night and tubes turned off for individual runs. `PNT` indicates whether a pointing check was done for that run. If it was, list the current in tubes 1-7 (see §5.2.4). `Comments` is where comments for the individual runs should be entered. Notes such as which tubes are turned off (if any) and whether any of the tasks had errors during the run (see below) should be included. NOTE: If the run is aborted for some reason put an entry like `*** Aborted ***` somewhere on the top line of the entry for that run. It will help people when they collect lists of runs for source analyses. Also note if the detector arrangement changes at all. For instance, if you operate with the 4-fold trigger, make it very clear which runs were done in this mode.

The entries at the bottom are for the night's comments. `Observer` should just be the observer's initials. Everyone who is there that night should be on the list, not just the person running the controls. `SKY` is where the weather for the night is entered. If it changes, add this information there. `Comments` should be general night comments and it is also where the quicklook results (see Chapter 3) should be recorded. If tubes are dead or voltages are changed for that night, make sure you record it here.

The `Discriminator Values` entries are where the voltages of the high level discriminators should be recorded. See §5.5.1 for how to determine and adjust these values. The `Quicklook results` entry is where the results of the quicklook analysis should be listed. List the source name, the runs, the individual run significances (and gamma ray rate if it is a source), and the totals for each source taken that night. The `Data acquisition problems` entry is where all the important error messages from the Data Acquisition System should go.

6.2.3 Display windows

See §2.8.3

6.2.4 Control errors/problems

Producer errors

Dropped frames This error occurs if the producer does not read the data quickly enough or because there is no data to read. This does not happen very often any more but it does happen occasionally. If one or two happen in a run just note the number of them in the `COMMENT` file. If several start occurring one after the other, it means the data is not coming in. That could occur if the HV is not on or if one of the electronics racks is not powered. If you cannot identify the problem quickly and fix it, end the run and get some help.

Writer errors

Lost cycles This occurs if the *WRITER* task does not write the data to the file before the producer overwrites it with another set of data. If it starts to happen a lot, it means something is taking up too much CPU time. Make sure no one is doing something silly like running MPEG movies or high CPU jobs on *taurus* during data taking.

6.3 Data collection

There are several different kinds of data runs that will be taken during each night of observations. They are described below in general detail along with the method for starting each kind and what they are used for.

The terminal will beep a number of times when the run is finished.

6.3.1 Laser File

The laser file should be collected at the start of the night's observing. The telescope is triggered by flashes from a laser which evenly illuminates the camera face. The mean ADC values recorded by the PMTs can then be used to match their gains in software. This file should be collected and analyzed before starting to analyze the other data files.

For a laser file, the telescope should be pointed toward some part of the sky not containing any bright stars, or at stow. Make sure all the PMTs are on. To get the pulser ready, follow the directions in §5.4.

This involves switching the laser on in the UPS/optics room. The laser data itself is acquired by clicking the `TRACK` button in the *GRANITE* program. After 3 mins or so have passed, you should click `STOP` to end the run and then `EXIT` to kill *GRANITE*. Restart *GRANITE* with the command `r granite`.

NOTE: Don't forget to switch off the power to the laser when you are done. It will be pretty obvious if you haven't as the rate will be very high on your next run.

In the event display window (see Figure 7.1), make sure that the tubes are recording strong pulses (big circles) from the pulser. A low gain could mean the HV is off or low or some other more complex problem. Any strangeness in the display should be noted in the `LOG FILE`.

6.3.2 Zenith File

The zenith file can be collected at any time during the night. It is often easiest to take the run while slewing in azimuth to a new source. These files are used to test the overall stability of the system and they are a record of the trigger rate (and therefore the energy threshold) of the detector.

To move the telescope to the zenith use the **ZENITH** option in the **COMMANDS** button in the tracking program or move it yourself by hand. It does not have to be exactly at the zenith so move it to regions devoid of bright stars. See §5.2.4. Start the run by clicking the **ZENITH** button in the *GRANITE* program. This will start a 10 minute run. See Figure 7.1.

If you are doing this while slewing in azimuth to a new source note it in the `LOG FILE`.

6.3.3 Tracking runs

These are the discovery mode runs where the background is calculated from the events whose α parameter values are inconsistent with the source direction.

Before starting a tracking run, make sure none of the PMT currents are too high (see §5.8.1). If there are some, turn them off. To start a tracking run, click the **TRACK** button in the *GRANITE* program. See Figure 7.1.

The event display will show ADC counts. Watch the event rate and tracking histograms. If the rate changes by much, it could mean bad weather (or at least clouds) are starting to move in.

6.3.4 On/Off pairs

These runs are taken when careful confirmation of a source or emission feature (such as variability) is needed. They are also used for objects like supernova remnants where the source location is unclear and 2-D analysis must be done.

Before starting the *On* run, make sure none of the PMT currents are too high (see §5.8.1). If there are some, turn them off. The *Off* region should also be checked for hot tubes and those tubes should be turned off for the on run as well. This improves the consistency of the two runs. To start the *On* run click the **ON** button in the *GRANITE* program. To start the off run click the **OFF** button in the *GRANITE* program after the *On* run has completed. If taking *Off* then *On* runs, start the *Off* run with the **PAIR 1/2** button and the *On* run with the **PAIR 2/2** button. See Figure 7.1.

The event display will show ADC counts minus the pedestal values. Watch the event rate and tracking histograms. If the rate changes by much, it could mean bad weather is coming in, or at least clouds.

6.4 CONTROL commands

This section lists some commands which can be executed from the *COMMAND INPUT* window shown in Figure 7.1. In general, the format of a command is

`/program_name/command/sub_command parameter(s)`

However, where no ambiguity is involved, only the `sub_command parameter` is necessary, and you only need to enter as many letters as is necessary to avoid ambiguity. This is the same way that VMS handles commands. For example, the command `/CONTROL/SET/CHECKTIME` can be abbreviated to `CH`. This is an extreme example, but it illustrates the point.

6.4.1 Status commands

status Alias: **/producer10/show/status**. Show the status of the acquisition process (*PRODUCER10*).

writer Alias: **/writer/show/status**. Show the status of the data writing process (*WRITER*).

server Alias: **/server/show/status**. Show the status of the *SERVER* task.

track Alias: **/server/show/tracking 10**. Show the latest information from the 10m telescope PC.

ccd Alias: **/server/show/ccd 10**. Show the latest information from the 10m CCD PC.

6.4.2 Control commands

check Alias: **/control/set/checktime**. Compare the VAX and GPS clocks.

sync Alias: **/control/set/synchronise**. Synchronize the ALPHA and GPS clocks.

/control/run/start # Update the run number to #. If no number is input, the run number increases by one. This is called at the start of every run.

6.4.3 Task specific commands

Server

trackon Alias: **/server/set/track_10 on 25**. Turn on the 10m tracking data portion of the *SERVER* process.

trackoff Alias: **/server/set/track_10 off**. Turn off the 10m tracking data portion of the *SERVER* process.

ccdon Alias: **/server/set/ccd_10 on 42**. Turn on the 10m CCD data portion of the *SERVER* process.

ccdoff Alias: **/server/set/ccd_10 off**. Turn off the 10m CCD data portion of the *SERVER* process.

Producer10

/producer10/set/scaler # on (off) Enables (disables) the read out and control of Camac scaler #. This can only be done between runs and once it is set it is not unset until the command is reissued or *GRANITE* is exited. The scalers are enabled by default.

/producer10/set/burst on (off) Enables (disables) the readout of the LeCroy 2251 burst scaler. This can only be done between runs and once it is set, it is not unset until the command is reissued or *GRANITE* is exited. The scaler is enabled by default.

Consumer

adc Display ADC pedestals distribution.

spectrum Display ADC spectrum.

trigger Display ADC trigger rates.

print Print current plot.

/consumer/set/range off opt1 opt2 Set autorange off on event display. `opt1` = minimum value. `opt2` = maximum value.

/consumer/set/rate # Set update rate of event display (1/Hz). Be careful, this can really slow down *taurus*.

/consumer/display/adc Display raw ADC values.

/consumer/display/pedestal Display pedestal values.

/consumer/display/signal Display ADC values after pedestal subtraction.

/consumer/display/rate Display PMT singles rates.

/consumer/display/histogram on (off) Turn on (off) display of event rate and tracking histograms in the event display.

6.5 Data tasks

6.5.1 Data transfer to Veritas

Transfering data files to *draco* from *taurus*:

Simply enter the command: **get #####** in a *draco* window. For example, to transfer gt012345.fz, type **get 12345**. To transfer more than one file, just type another number on the command line. The data is transfered to `/eltanin/raw10/dYYMMDD`. To transfer more than one file, just type another number on the command line.

To transfer the collected data files from *draco*:

Enter the command **transfer_10** at the *draco* prompt. The files will be zipped and placed in the `/data/raw10` and `/crab/raw10` directories on *veritas*. If you forget to perform the transfer on the same UTDate, say 001001, you can do the following to transfer the data **transfer_10 001001**.

6.5.2 Data Compression/Uncompression

Compressing Unix files

Data files on the Tucson Unix machines may be compressed with the command **bzip2 filename**

6.5.3 Backing up data to tape

If space on the data disk on *taurus* is low (use the command **show dev dir$data** to see how much free space is available on the disk), make sure the data has been transferred to *egret* and *draco*. Once you are sure the data is on the two computers, delete it from *taurus*. From *draco* the data should be backed up to tape. Each data file should be on at least **TWO** data tapes before it can safely be deleted from the *draco* disk.

To find out which files have been backed up look in `~/raw10_backups` on *draco* where a list is kept of all the data on tape. The DAT tapes are kept in a drawer underneath *pleiades*, so check there too.

To do a backup, change directories to `/data/raw10` and insert a new 4mm tape into the tape drive on *draco*. Type **du -ks *** to show the combined size of all files in each directory in kilobites. Calculate which directories will fit on the tape (a DAT tape holds 2 gigabites or about 2000000 kilobites). Start a script session by typing **script backup.yymmdd** (where the date is the current UT date). Once the script has started give the command **tar cv0 dYYMMDD dYYMMDD ...**, where the arguments are the list of directories that will fit on the tape. This will tar these directories and write them to tape. When the backup is finished (and has been verified successfully), exit the script session by typing **exit**. Eject the tape from the drive and label it appropriately and store it with the other backup tapes. Finally copy the backup script using the command
cp backup.yymmdd ~/raw10_backups.

Once this has been done (and verified), it is then OK to delete data files that are on more than two backup tapes.

The details of this backup (date, run numbers and their dates, and who did it) should also be recorded in the tape backup log book. **Which is located where?**

6.5.4 Restoring data from tape

Occasionally, files will need to be taken from a backup tape and restored to disk. The instructions below show how to do this with 4mm DAT tapes on *draco*.

To see if a file is on a backup tape

(1) Place the 4mm tape in the DAT drive on *draco*.

(2) Enter the command: **tar tv0**. This lists the contents of the tape to the screen.

(3) Retrieve the tape by pushing the button on the tape drive.

To retrieve files from the tape

(1) Place the 4mm tape in the DAT drive on *draco*.

(2) Enter the command: **tar xv0** *filename*. This extracts the file and puts it into the working directory. The filename must consist of the complete path name as it appears on the tape (*eg.* `d980401/gt010123.fz.gz is a complete filename`). If you leave off the filename, `tar xv0` will extract the entire tape and copy it to the working directory.

Chapter 7

Data Acquisition on tuarus

7.1 VMS Handy Hints

NOTE: There is a file called *"Taurus-digital-au600-user-guide.pdf"* in `/home/observer/Useful` on *draco*. It is a user manual for *DIGITAL au600* (*ie taurus*).

7.1.1 changing directory

To change directory type **set def fullpathname** or alias of full pathname e.g. **set def dir$pro** puts you in the directory which you should run the Granite data acquisition from.
To return to your user's top directory type **home**.
To go down into a subdirectory type:
down subdirectoryname or **down subdirectoryname.subsubdirectoryname**
and to go back up one level in the directory structure type **up**
To list directory contents, type **dir**

7.1.2 miscellaneous

- by default, when you edit the command line in a DECterm window you over-write the previous text. To change to insert mode press <**ctrl**>**a**.
- **HELP** will give you a list of topics to ask for help on. It's like typing "man" in unix but more satisfying.
- To list the contents of a directory type **dir directoryname**
- to check which directory you are in type **show def**
- VMS is not case sensitive.
- To stop the screen scrolling, press F1 - this is the "hold" on this keyboard. To release the hold press F1 again.
- **type filename** is sort of equivalent to "more filename" in unix and will print the contents of an ascii character file to the screen. If you accidentally **type** a binary file you may need to *Clear Communications* and *Reset Terminal* by selecting those options from under the menu item "Commands" at the top of the Decterm window before what you type bears any resemblance to what appears on the screen.

- **copy originalfile duplicatefile** does what it says.
- **rename oldfilename newfilename** does what it says and can be used to move a file from one directory to another for example, **rename usr1:[observer]filename usr1:[observer.granite]filename** will move `filename` to the subdirectory `granite` of the user observer's home directory.
- To create a subdirectory: **create/dir [.subdirectoryname]**
- To execute a .com command file **@filename**
- To check the space left on a disk, type **show dev DISKNAME**. To check the space left on the default data disk type **show dev dir$data**
- To see what jobs are running type **show sys**
- to change the ownership of a file or directory type **set security/owner= newowner filename**
- to view the permissions on a file i.e. who is allowed to read, write, execute or delete it, type **show security filename**. For examples of how to change the permissions type **help set security**. Most frequent use is to change the permission on a directory so that the owner can delete it: **set security/protection=(o:rwed) directoryname**
- To change your password, type **set password**. For an example VMS password type **help set password example**

7.1.3 exporting the display from *taurus*

To open a window from taurus on another machine you must set the display variable (equivalent to setenv DISPLAY machine:0 in unix). For example:
set display/create/transport=tcpip/node=draco.sao.arizona.edu

7.1.4 version numbers

When a file is saved the old version is not automatically over-written as in unix, instead a new version number is created e.g. granite.kumac;2 is the second version of the file granite.kumac. This means that unwanted versions often clutter directories and you should purge regularly (see below).

7.1.5 wildcards

The asterisk is used as the wildcard character, so you can specify for example filename.* or *.fz or filename.fz;* (all versions).

7.1.6 deleting files

delete filename will ask you if you really want to delete the file.
delete/noconf filename will delete it without asking.
delete/noconf *.*;* will delete everything in the directory without asking!

7.1.7 purging old versions

purge filename will ask you which versions of the file you want to remove. **purge/noconf filename** will leave you with just the latest version (highest version number).

7.1.8 the point-and-click editor on *taurus*

To edit a file type **xlse filename**. If you click on the DECterm window you will still have a command line prompt. To save the file select **save** under the menu header **file**. Then **quit**.

This often has no license though, so you can ftp to *taurus* from *draco* and **get** a text file, edit it using *eg* emacs, and then **put** the file back on *taurus*.

7.1.9 defining a directory alias

The aliases for the data directory, current granite version and current gdf version are defined in the user observer's home directory in the file login.com. You might want to change these if you want to use a new version of gdf or granite or return to an older version, or...

if the data disk dies...

Open a new window as observer on taurus
Edit the file *login.com*
xlse login.com
change the line *define dir$data usr2:[observer]* to e.g. **define dir$data usr1:[observer]**
save the file and quit the editor **CTRL-Z** then **write** then **exit**
type **@login.com** to execute the login.com script
This changes the default data location to the disk *USR1*, the *GRANITE* program disk. This should only be a temporary measure. Ensure there is enough space on this disk (again by typing **sh dev dir$data**).

7.1.10 logging in under another user's session

Usually the desktop session on taurus belongs to user *observer* (password from Appendix D) as the Granite data aquisition program is run under this account. If you need to log in e.g. as system, you can do so in a DECterm window without exiting the desktop by typing:

set host 0

system

enter password from Appendix D
To be able to open a window e.g. the xlse editor, you must set the display variable by typing:

set display/create/node=taurus

7.1.11 to restart the DEC window manager

Log in as system as above and type **@decw$startup restart**

7.1.12 killing unwanted processes

If you suspect you have some unwanted "zombie" processes, login as system as above and type **show system/full**. Generally these processes e.g. Granite windows which won't close are described as *swapped out*. To kill them type, for example, **stop/identification=0000049E** where the hex. number is the PID (process ID) number listed in the first column. If you can't work out which process to kill, then you may have to re-boot.

7.1.13 re-booting *taurus*

Exit the observer desktop session by pressing the exit button on the bottom menu bar. Log in as **system**, password from Appendix D and type **@shutdown**.

If you need to shutdown remotely, you can telnet to it as system and type **@shutdown**.

Type **b** (when on the blue screen) to reboot *taurus*.

7.2 TEST PROGRAM LIBRARY

A library of short programs to interact with the data acquisition electronics independently of the main Granite program exists in the directory *USR1:[OBSERVER.QUINN]*. Most frequently used are:

7.2.1 program "scalers"

Use: to read out the LeCroy and Philips singles rates scalers in crate 5.
To invoke, type **scalers**

7.2.2 program "cfds"

Use: can be used to set the threshold of the constant fraction discriminators in crate 6, to mask off individual discriminator channels, trigger the CFDs via a CAMAC command etc. and take a multiplicity trigger bias curve.

To invoke, type **cfds**

Note: it has been found that a couple of CFD channels do not fire when given the CAMAC trigger command and that the output pulse width of at least one CFD module can no longer be programmed due to a bad chip.

7.2.3 gain matching

The programs "gain_calc" and "gain_match" are used to create a new high voltage settings file given the old file and a matching nitrogen file. A description of how to do this is given in the file
USR1:[OBSERVER.GAIN_MATCHING]GAIN_MATCHING.TXT

7.2.4 program "pst_bias"

Use: reads out channels 8 and 10 of the scaler in crate 4 (also used for elapsed time and livetime). The user chooses a range of CFD thresholds to cycle through e.g. from 20mV to 100mV in steps of 10mV and the scaler is allowed to run for a chosen time at each discriminator setting, to produce a bias curve for the multiplicity (ch 8) and pattern (ch 10) triggers. To invoke, type **run pst_bias**.

7.3 GRANITE ADVICE

Getting started:
set def dir$pro
run granite/nodebug

When Granite first starts up, it executes the instructions in the file GPR10.KUMAC. It echoes the instructions it is following to the DECterm which you started it from. These are mainly instructions for the producer thread which has to decide which modules in the CAMAC crates should be read out and then compile programs for the list processors (the modules which independently control what goes on in each crate once the run has started). Some example lines from GPR10.KUMAC:

producer10/set/scaler 5 4 off — under repair *tells the program that it should not try to read a scaler in slot 4 of crate 5*

***..producer10/set/pst/state 4 13 off** *this instruction not to read the pattern trigger module in slot 13 of crate 4 is commented out with a "*.. ", which means that the module is therefore "on" and being read out because this is the default state.*

producer10/set/pst/load 4 0 PST_MUL2.DAT *this instruction tells the Granite program to write the data in the file PST_MUL2.DAT to all of the pattern trigger modules which are "on" in crate 4. N.B. this only needs to be done when the power has been cycled on that crate. See Pattern Trigger instructions in §8.*

setting CFD thresholds

The command in GPR10.KUMAC: **producer10/set/disc_thresh 6 -1 -1 75** *is the instruction to set the threshold of all of the channels (-1) of all of the constant fraction discriminator modules (-1) in crate 6 to 75mV.* This command to set the discriminator thresholds can be entered into the Command Input window by hand. Don't forget that if you quit and re-start Granite the CFD thresholds will be re-set to the value given in GPR10.KUMAC, so if you want to run all night with a different threshold it is best to edit the text file (**xlse gpr10.kumac**) change this line and save the file. Don't forget that as VMS saves old versions of files you can always recover the original.

Command Input

Note that the program will not allow you to change most things *during* a run. You can copy the instructions from the DECterm or GPR10.KUMAC into the Command Input window, but must then edit the text in some way and then press **Enter** for the command to be sent.

If you type **HELP** in the Command Input window, a menu of command categories will appear *in the DECterm window.* For example, if you then select option 14 "producer10" (entering your selection in the DECterm window not the command input window) and then option 9 "set", you will be given a list of possible commands relating to the status of the CAMAC modules. Choose a command and you will be told its syntax and default values. Then type the command into the Command Input window.

7.3.1 Run Control

When you click on a button in the Run Control window (see Figure 7.1) Granite executes one of the "macros" (lists of commands) given in the file GRANITE.KUMAC (in principle it is also possible to enter these commands individually in the Command Input window). If you want, for example, to change the duration of a zenith run from 10 to 15 minutes, you can do this quite simply by editing the text file (**xlse granite.kumac**) changing the line *time/now 10* to *time/now 15* and saving the file.

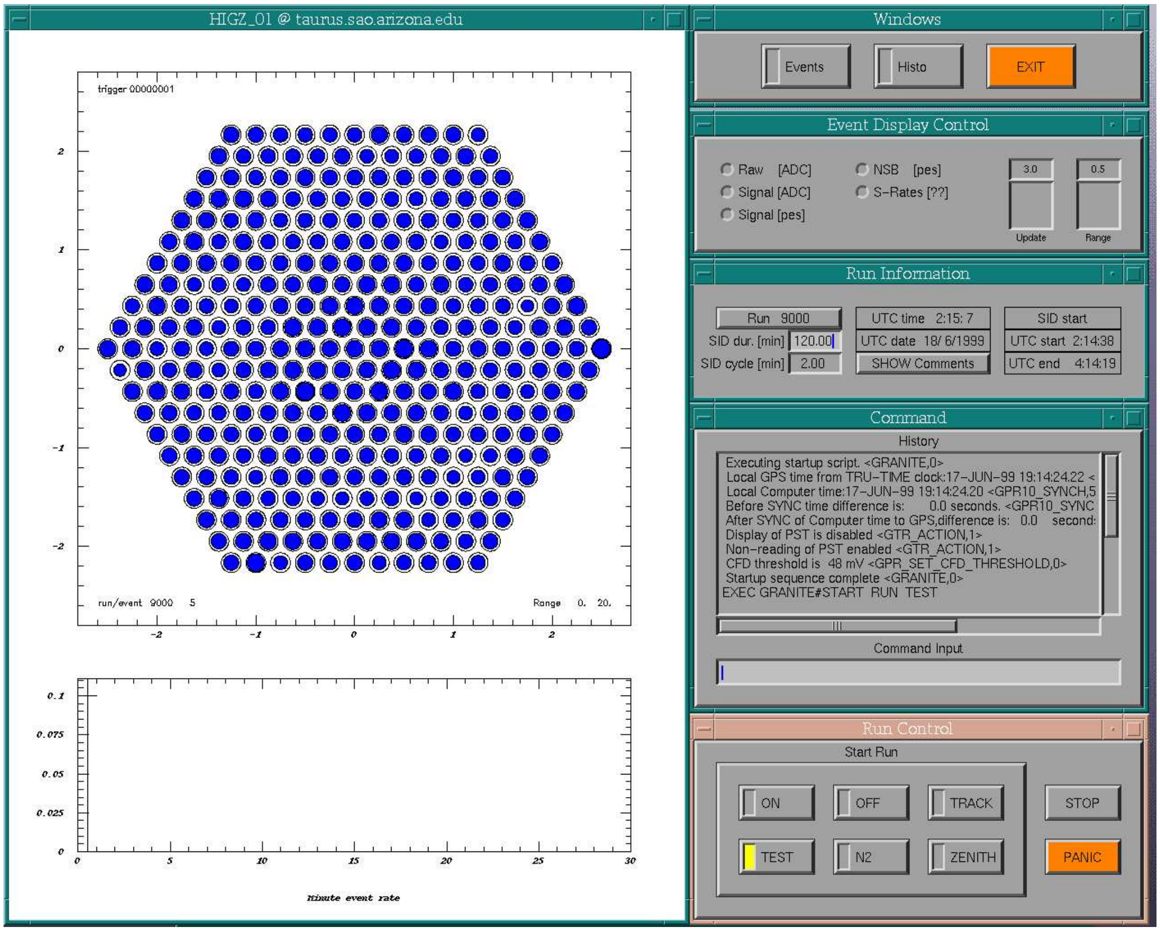

Figure 7.1: The Data Acquisition Display

the N2 button

This is currently not used as the nitrogen lamp has been replaced by a laser and it sufficed to take a 3 min tracking run with it instead

Executes macro *start_run_n2*.
Starts recording a 1 minute nitrogen run. During a nitrogen run, the event rate is so high that the program only opens the gate to accept events for just a few tens of microseconds until the buffer is full, then reads out the data, then lets in another burst of events etc.

the ON button

Executes macro *start_run_on*.
Starts recording a 28 minute run at the next siderial minute.

the OFF button

Executes macro *start_run_off*.

Starts recording a 28 minute run starting 28+2 minutes after the start time of the previous ON run. Don't panic if you have hit "OFF" instead of "ON" as this only really effects the start time. This does mean though that if your ON run finished early (crashed) and you then try to start an OFF run you will have a long wait before the run starts!

the TRACK button

Executes macro *start_run_tracking*.
Immediately starts recording a 28 minute run.

the ZENITH button

Executes macro *start_run_ped*.
Does exactly the same as the TRACK button, but has run duration = 10 minutes.

the TEST button

Executes macro *start_run_test*.

Starts a run of nominal duration 2 hours. It does not write a file to disk. The test run is always number 9000. REMEMBER to check what the next real run number should be by typing **dir dir$data** when you have finished taking test runs (see §7.3.2 on run numbers). Press **STOP** to end the run. It may not be possible to start another run without quitting and re-starting Granite after a test run. Make sure that the run number is reset to its proper value after performing a test run.

7.3.2 run numbers

The information from the run information window is recorded in the file GDF_RUN.DAT (not ascii) in the data directory and the latest version is read back in whenever Granite is started. This means that Granite has a record of the last run number and will automatically start the next run with the last run number + 1. If for some reason you want to record a different run number (e.g. if you have been using the test button) then you must press the run number button in the *RUN INFORMATION* window. A window will pop up where the desired run number of the next run can be entered. Granite decided which camera to display e.g. 331 or 151 pixels on the basis of the run number, hence *you must choose a run number ≥ 9000 for the 331 pixel camera*.

7.3.3 the Event Display

Using the buttons in the Event Display Control window you can choose to display the raw ADC values in each tube, or **Signal(ADC)** the ADC values after pedestal subtraction (the pedestals are calculated "in flight" during the run), or **S-rates** the single-fold trigger rate for each tube read out from the scalers in crate 5. The other options are not implemented. The filled circles which are drawn are automatically scaled according to the highest single tube value in the event. Open circles indicate negative values (after pedestal subtraction). It is possible to change the scaling factor by pulling down the *range* bar. Events are displayed at regular intervals unless the amount of data in the buffer which needs to be written to disc is too great and the program is therefore too busy to update the display. For the raw and pedestal subtracted ADC count displays, the green and red colours indicate values of 2.25 and 4.25 standard deviations above the mean for that tube i.e. they correspond to analysis boundary and picture pixels. The run number and event number are displayed to the bottom left of the camera. In the top left is the trigger tag. This tag is read from an event register where bit 1 on → a pedestal trigger, bit 2 on → a pattern trigger and bit 3 on → a multiplicity trigger. Hence trigger tag 0000001 is a pedestal event, 0000006 (both bits 2 and 3 on) indicates that both the pattern trigger and the "normal" multiplicity trigger fired etc.

7.3.4 the ECC software

If Granite crashes check that the ECC software to control the crates is running: type **ecc/show=crates** this should list crates 1, 3, 4, 5 & 6 (no, there is no crate 2 yet). If crate n is missing from the list it's a good idea to go and flick the reset switch on the front of the crate controller module (far right of crate n). If instead of a list you get an error message "global section ECC$GBL does not exist" the software has crashed and you must re-load it by logging in as system:

set host 0
system
enter password from Appendix D
ecc/load

You should be told "identification of created process is ...". Sometimes this message appears but the software instantly crashes again, so to be sure that it is running repeat the **ecc/load** command - if everything is OK you should then get the message "process creation failed, duplicate name". If this doesn't work, it is probably because you have a program still running somewhere e.g. one of the test programs which thinks it is still in contact with the crates. You will have to find and exit this program and try **ecc/load** again.

7.4 Reading a raw data file

gdf_example is a program which opens a raw data (.fz) file and prints out selected variables from the granite data format (gdf) for each event. To find it type **set def dir$gdf**. To choose which variables you want you must edit the program file *gdf_example.for* and re-compile gdf by typing **@gdf** to execute the script gdf.com. To see what variables exist in a 10m event record, type
type gdf_ev10.tex.
To run the program, type:
set def dir$gdf
gdf_example :== "$ dir$gdf:gdf_example.exe" (to set up a command alias)
gdf_example dir$data:gt009038.fz to run the program on your chosen raw data file.

7.5 Creating a new user account

So, you enjoyed your introduction to VMS and would like your very own user account on taurus? Log in as *system*, password from Appendix D and follow this example (bold font indicates what you should type at the prompt):

set def sys$system
run authorize
show [*,*]/brief *lists existing users and their user identification code (UIC). You need to choose a UIC which doesn't already exist for your new account.*
add burdett /password=sillypassword /UIC=[300,21] /device=usr1 /directory=[burdett] /owner="Andrew Burdett" /account=whipple
exit
set def usr1:[000000]
create/dir [.burdett]

set security/owner=burdett burdett
logout

7.5.1 if you've forgotten your password...

Been away so long you can't remember your password? Log in as system and **run authorize** as above. Then:
modify/password = newsillypassword burdett
exit

Chapter 8

Pattern Trigger

8.1 Hardware

8.1.1 Pattern Trigger Modules

13 Pattern Selection Trigger modules (PSTs) are used to cover the 331 inner pixels of the 490 pixel camera. A single module receives the CFD ECL output pulses from each of 59 pixels. Inside the module these 59 pixel signals are sorted/copied into five sets of 19 signals covering 5 overlapping hexagonal patches of 19 pixels (see the paper from the Kruger Park Workshop, appended). These signals are input to the address lines of one of 5 memory chips.

The mapping of pixel signals from the CFD outputs to PST module channels can be found from the Pixel Router user guide.

The memory should contain a ”yes” at an address corresponding to an allowed combination of pixel signals. If the pixel signals reach a “yes” decision, a TTL trigger flag is set on the back pins of the module. The 13 modules are in slots 1 to 13 of crate 4. They are linked at the back by a daisy chain connecting their VETO, Global Enable and TRIGGER output pins (see Hytec PST User Guide appended). This means that when a module is triggered it issues a veto which prevents the rest of the modules from triggering on another, later event and when a Global Enable command is issued all modules are almost simultaneously ready to accept signals. When you attatch the daisy chain to the bottom five pins of each module it is vital that you make sure that the connectors are all the right way up, since one side of a pair of pins is at ground and the other at 5V. Check using a multimeter, therefore, that the outer casing of the flying lemo cable (which carries the trigger signal) is at ground. Be careful if you are pushing modules into the crate to ensure that the daisy chain does not get caught between the back of the module and the crate. Never move modules with the crate powered on.

The TTL trigger signal is taken from the daisy chain lemo cable over the top of crate 4 and into a TTL/NIM level translator in NIM bin B. There is an additional 3ns length of lemo cable here which has been added to delay the PST trigger signal in order that it arrives at the main telescope trigger logic gate (Nim bin A slot 10) at the same time as the “normal” multiplicity trigger pulse.

As the PST trigger signal remains “on” until the PST modules are cleared, it is input to a discriminator in order to generate a 70ns wide PST trigger pulse. One output from this discriminator goes directly to the telescope trigger logic, input C, where it can be ”OR-ed” with the multiplicity trigger pulse (input A) and the pedestal 1pps trigger pulse (input B). The other output is fanned-out using a level translator to give NIM signals to the event register, event scaler and (optionally) a PST-clear signal and an input for the visual scaler. See Figure 8.1.

8.1.2 The Pixel Router

The Pixel Router (formally known as the ECL Signal Splitter!) is the VME crate smothered in ribbon cables. It accepts the ECL output signals from the CFDs in crate 6 via 16-way twisted pair cables, copies and redistributes them for input via 30-way cables to the 13 PST modules. As we want all possible combinations of adjacent pixels in the camera to be covered, the signal from a single pixel may be copied to up to 3 different outputs i.e. 3 different PST modules. The Pixel Router input and output cards basically carry a lot of identical triple line receiver chips (10H116 - see the Motorola MECL Data book). The copying of signals is done by multiple wire-wrapping at the back of the crate (feel free to unscrew the back panel and take a look). The main cord to the back of the crate provides power to an internal 5V power supply, but the output of the 5V supply is controlled by a switch on the front of the fan tray beneath; the green light indicates that power is supplied to the cards.

It is intended that the middle connector on the multi-coloured ribbon cables from the CFD ECL outputs should be plugged into the Pixel Router inputs and the ends of the cables should be terminated by being plugged into the singles rates scalers in crate 5. However, when there are scaler modules missing, the end rather than the middle connector of the ribbon cable should be plugged into the Pixel Router input in order to avoid reflections. Also, these input cards should have terminating resistors plugged into them. Sockets already exist on the boards for these orange 3 x 100 Ω resistor packs. If for some reason there is no cable plugged in to either an input card or an output card, small grey jumpers need to be put on the unused channels (to tie one side of the signal line to a "medium" voltage) and any terminating resistors removed. Channels labelled "spare" on the input cards should be jumpered regardless of whether a terminating resistor is in place as they are not connected to the input. *Remember, if the input cable does not go on to a scaler the Pixel Router input card must have terminating resistors added. If the cable does go to a scaler, terminating resistors must be removed.*

8.2 Programming the PST

The main data acquisition program, Granite, is used to generate and write valid combinations of adjacent pixels to the PST modules.

To generate a file containing valid combinations of n adjacent pixels (in a group of 19) start granite and type **/trigger/configuration/file n filename** in the Command Input window, where n = 2,3 or 4. At present these files already exist in the directory dir$pro and are called PST_MULn.DAT.

You must then tell Granite which PST modules are on-line so that it doesn't try to write to ones which aren't in the crate for some reason. By default Granite assumes that there are 13 PST modules on-line in slots 1 to 13 of crate 4. If for some reason one of these slots is bad and you need to put a module in some other slot in the crate then you must edit the file GPR10.F90 and re-compile Granite accordingly - ask Andrew, Stella or Glenn. You can tell Granite to ignore one or more of the 13 modules it expects by entering the command **producer10/set/pst/state 4 x off** where x is the unwanted module's slot number.

Now you can set the multiplicity threshold of the PST - this sets a comparator reference voltage. If the summed input signals to the PST exceed this voltage level then it proceeds to check the result of the "memory look-up" operation. If they do not then there were not enough pixel signals to constitute an n-fold trigger and to save time the memory look-up check is abandoned. To do this type

producer10/set/pst/multiplicity 4 -1 n

where 4= crate number 4, -1= all on-line modules and n=2,3 or 4-fold multiplicity.

Now load the PST memories with the file of valid patterns of n adjacent pixels by typing:

producer10/set/pst/load 4 0 PST_MULn.DAT

where 4= crate number 4, 0= all on-line modules and n=2,3 or 4-fold multiplicity.

Now check that the memory loading operation was successful by reading out the contents of the PST memories and comparing them with the PST_MULn.DAT file:
producer10/set/pst/verify 4 0 PST_MULn.DAT
The **load** and **verify** operations take 2 minutes each for 13 modules.

All of these command lines appear in the current version of the file GPR10.KUMAC. The commands in GPR10.KUMAC are executed whenevr you start up Granite. **You should only have to perform the PST multiplicity, load and verify operations after cycling the power to crate 4**, so the commands are normally "commented out" in the GPR10.KUMAC file by putting the characters ***..** at the start of the line.

N.B. as the load and verify operations take 4 minutes in total you should avoid cycling the power to crate 4 in desperation during the night as far as possible - settle for flicking the crate controller reset switch!

8.3 Recording Data with *Granite*

When Granite is started, it executes GPR10.KUMAC and the PSTs are set on-line or off-line as described above. When a run starts, Granite issues a global enable so that the PSTs are ready to receive signals and generate triggers. When a telescope event trigger of any sort occurs, data words are read from all of the on-line pattern triggers in the crate via the CAMAC backplane. One word is read for each group of 19 pixels which contained a signal. The type of trigger is recorded by the event register in crate 3, where bit 1 on → pedestal event, bit 2 on → pattern trigger and bit 3 on → multiplicity trigger. Hence an event which triggered the PST only will appear with trigger tag 0000002 in the top left corner of the Granite event display and one which fired both the multiplicity and PST triggers will have tag 0000006.

8.3.1 Active Mode - PST as the main telescope trigger

In order to use the PST trigger as the main telescope trigger rather than the multiplicity trigger, you have to remove the pin from hole C in the 1-fold logic gate in NIM bin A slot 10 (bottom half) and put it into hole A. A *telescope trigger* will then occur if there is a pedestal event (input B) OR a PST event (input C). The multiplicity trigger (input A) is not included in the OR operation.

The PST modules have to receive a clear pulse before they are ready to respond to a new event. When the PST is being used as the main telescope trigger the modules should be cleared by the same pulse from the SOB in crate 3 which signals that the data from the last *telescope trigger* event has been read out and lifts the veto to the telescope trigger logic. **This CLEAR signal is taken from the bottom two NIM outputs of the level translator in slot 4 of NIM bin B to the two PST clear fan outs**. In this case the List Processor in crate 4 reads the data words from the PST modules before they are cleared. These data words are then recorded as the are in the GDF data file and also decoded by Granite (routine in GR_TRIGGER.F90), and presented on the event display as hexagons drawn around pixels, indicating that the PST saw a signal from this pixel. At least two of the hexagons should be adjacent or there is probably something wrong with the programming of the PST or the event readout (tell Stella).

8.3.2 Passive Mode

Not all events which trigger the PST also trigger the multiplicity trigger and vice versa. If the multiplicity trigger is being used as the main telescope trigger it is possible that an event will occur which generates a PST trigger but no *telescope trigger* and hence the PST will not be cleared in the above CLEAR configuration. When the next *telescope trigger* occurs, the information which will be read out from the PST will then belong to the previous event. In practice the event display will show PST triggered tubes with no ADC signal in them. In order to avoid this mis-information, the PST should be set up so that it is “self-clearing” i.e. it is cleared by its own trigger pulse before any data words are read from it. There is a T-piece hanging from a lemo cable coming from the level translator acting as the PST trigger fan out. The two lemo cables to **the PST CLEAR fan-outs should be** removed from the bottom two NIM outputs of the level translator in slot 4 of NIM bin B and **connected to either side of this T-piece labelled PST Bias Curve Clear**. Although there should generally be no hexagons indicating triggered tubes displayed in this configuration, the PST trigger to the event register will still be recorded and appear in the top left corner of the event display.

8.4 Taking a Bias Curve

A program exists on *taurus* in the directory USR1:[OBSERVER.QUINN] which reads out channels 8 and 10 of the scaler in crate 4. The user chooses a range of CFD thresholds to cycle through e.g. from 20mV to 100mV in steps of 5mV and the scaler is allowed to run for a chosen time at each discriminator setting, counting the number of multiplicity trigger pulses into channel 8 and PST trigger pulses into channel 10. In this way we can compare the multiplicity and PST trigger rates and select appropriate CFD thresholds to obtain a manageable data rate when running with Granite. To take a true bias curve you must have the PST “self-clearing” i.e. with the **CLEAR taken from the T-piece labelled PST Bias Curve Clear** as above. If the clear was left in the configuration used in “Active Mode” then it would be relying upon a pulse supplied by the List Processors, which cannot handle very high rates. This program does not have the facility to write to the PST memories so they must already have been loaded using Granite (see above).

To take a bias curve, open a DECterm as observer on *taurus* and type:

down quinn
run pst_bias
1

At this point the program initialises the connection to crate 4 and enables the PST modules to accept triggers. This takes a couple of minutes - do not be alarmed.

1
20
120
5
30

The program then cycles through, changing the CFD thresholds. A bias curve of this detail can take > 15 minutes. It then prompts you for a filename to save the rate data to.

Don’t forget that if you want to use the PST as the main telescope trigger you must change the PST clear back to the bottom two NIM outputs of the level translator in NIM bin B slot 4 after taking a bias curve.

8.5 Troubleshooting

8.5.1 Can't write to PST memory

When Granite writes valid patterns to the PST memories, it reads them back out again and compares what is read with the file it was writing from. It reports the result of the comparison for each module in the Command History window. If the "Memory Comparison Failed" for a given module, then probably a fuse has blown. This used to be a frequent problem because a 3 Amp fuse was used on a line drawing 3.3A, but most modules now have 5A fuses. Switch off the power to crate 4. Unplug the daisy chain cable from the back of the module and the ribbon cables and "clear" lemo cable from the front and remove it from the crate. You can reach the fuse with multimeter probes without removing the protective sides of the module. Hold the module edge on with the front end in your right hand. The fuse (FS2) is the first resistor-type component at the left hand end (coming from the +6V power line of the CAMAC crate). If it has an infinite resistance then you must exchange it! The fuse simply plugs in, so you can unscrew the cover of the module and pull out the old fuse. It should be replaced with a *5 Amp fuse*, although the socket may be labelled 3A. There are plenty of spare fuses in the plastic drawers in the electronics room. When you have put the module together, put it back in the CAMAC crate (while the crate power is off), taking care not to crush the daisy chain cable at the back of the modules. Switch on and try writing the to the PST memories again with Granite. If this fails, there is a spare PST module on the top "Leeds" shelf in the electronics room!

8.5.2 Unexpected event rate

Check the PST event rate using the visual scaler and lemo cable coming from the NIM output of the level translator in slot 4 of NIM bin B. Make sure that the visual scaler isn't "sticking" using a test pulse. Do NOT use the inverted NIM output of the PST CFD - gives kHz rate - or the spare output of the telescope trigger logic gate - gives zero rate if the List Processors are not running because the veto is always on.

No events

Is the power on crate 4?

Are the pattern trigger modules on-line or have they been switched off in GPR10.KUMAC?

Check that the Pixel Router is switched on; the green light on the bottom left of the crate should be lit. If it is not lit but the switch is in the downward "on" position, check that the two power cables into the crate itself and the fan tray underneath are plugged in, together with the power control line joining the two. Take a look at the "Pixel Router User Guide" and if all else fails, contact [redacted] in Leeds: [redacted].

Is there a CLEAR pulse reaching the modules? Check the logic diagram (appended) and search for loose or wrongly placed cables. Remember, if Granite is not running then the lemo cables to the PST CLEAR fan-outs should be connected to the T-piece labelled "PST clear bias curve".

Is the daisy chain at the back of the modules on the right pins - the bottom five pairs of each module - and the right way up - outer casing of lemo cable connector at ground?

If you are running with a test pulse into just a couple of channels, check that the multi-coloured ribbon cable from the appropriate CFD to the Pixel Router is properly terminated e.g. plugged into a scaler module. See Pixel Router instructions. Are the relevant ribbon cables plugged in properly? Try moving the test pulse to pixels which correspond to another Pixel Router input card - if you now have events then you may want to exchange the suspect input card - there are spares in the box labelled "spare pixel router boards" on the top shelf in the electronics room. The same logic applies to output cards. Check the Pixel

Router instructions (appended) to work out which output card(s) should have a signal on them. Make sure that replacement cards have jumpers and terminating resistors in the appropriate places.

kHz event rate

See §2.9.7 also.

Have the CFD thresholds been set since the last time the power was cycled on the CFD crate (crate 6)? If not then you should set them either via Granite or by choosing option 11 in the program "cfds" on *taurus* in directory USR1:[GRANITE.QUINN].

Are all ribbon cable connectors the right way up? The brown edge of the multicoloured cables and the red edge of the grey cables should correspond to the lowest numbered channel. That is to say that they should be uppermost EXCEPT for every other connector into the LeCroy scalers!

If the answers to the above are "yes" and "yes" then you probably have a loose ribbon cable somewhere which is either not properly plugged in or which the connector is falling off of. I wish you good luck in finding it. There are new 20-way and 30-way IDC connectors in the box labelled "Pixel Router Spares" on the top shelf in the electronics room. There is a reel of spare 30-way grey ribbon cable and several reels of the multicoloured TWISTED PAIR ribbon cable. There are dedicated tools for cutting ribbon cable off square and crimping connectors to it - ask Kevin for a demonstration.

If there are Pixel Router cards with no ribbon cables connected to them then they should have jumpers on the un-used channels. Channels with jumpers on them should not have terminating resistors as well.

Persistent triggers on certain channels

Some CFD ECL output channels may be "bad", since they have had to be repaired following lightning damage. For example, the Granite event display showed that one channel always had a pattern trigger signal. Looking at each side of the ECL signal from the CFD for this pixel using an oscilloscope probe showed that one side of the signal was at a constant level of -5V. We expect typical ECL levels of -800mV dipping to -1.1V on one pin and -1.8V rising to -1.1V on the other and a pulse width of about 23ns. If a CFD is bad you must either fix it (get Kevin to fix it?) or make up a new input ribbon cable with this channel cut out i.e. not in the connector. If you remove the channel then you must put a jumper on the corresponding input card channel and makes sure that there is no termination on that channel of the card (by cutting two legs off a resistor pack if necessary - there are plenty of spare resistors and jumpers in the box marked "Pixel Router Spares" on the top shelf in the electronics room).

8.5.3 Bad tag in crate 4

This "bad tag in crate 4" error messages may occur several times during a run. One theory is that this occurs with particularly large events where many data words have to be read from the PSTs. The read out of crate 4 is a bit of a black art as it is the only crate which has a variable amount of data per event.

You can try reloading the ECC software. See 7.3.4.

8.6 Lightning Precautions

In the event of a nearby electrical storm please disconnect the grey ribbon cables from the PST modules and the multi-coloured twisted pair ribbon cables from the Pixel Router inputs (and the scaler inputs where applicable). Really, these steps should only be taken at the end of a season if it is feared that there will be prolonged (a number of nights in succession) spell of lightning causing observations to be halted. The cables are quite brittle and can break very easily. This is not easy to repair.

The main things to disconnect if you feel that there is lightning in the are for the night are:

- **The GPS antenna:** Go to the back of the rack with the GPS (the second rack from the door). There should be a black coaxial cable with a BNC connector on it connected to the GPS unit. It should have a labeled piece of card with a lightning symbol attached.
- **The CCD camera:** If you look at the cables coming from the CCD computer, one of them should be a serial cable. Beside the monitor for this computer, there should be a joint in this cable where it can be disconnected. It is labeled in the same way as the GPS cable above.
- **SGARFACE GPS antenna:** You will find SGARFACE behind all of the electronics racks. If you go around the racks to the side with all the delay cables and then face SGARFACE, to the top left of the you will see a black coaxial cable labeled in the same manner as the GPS cable above.

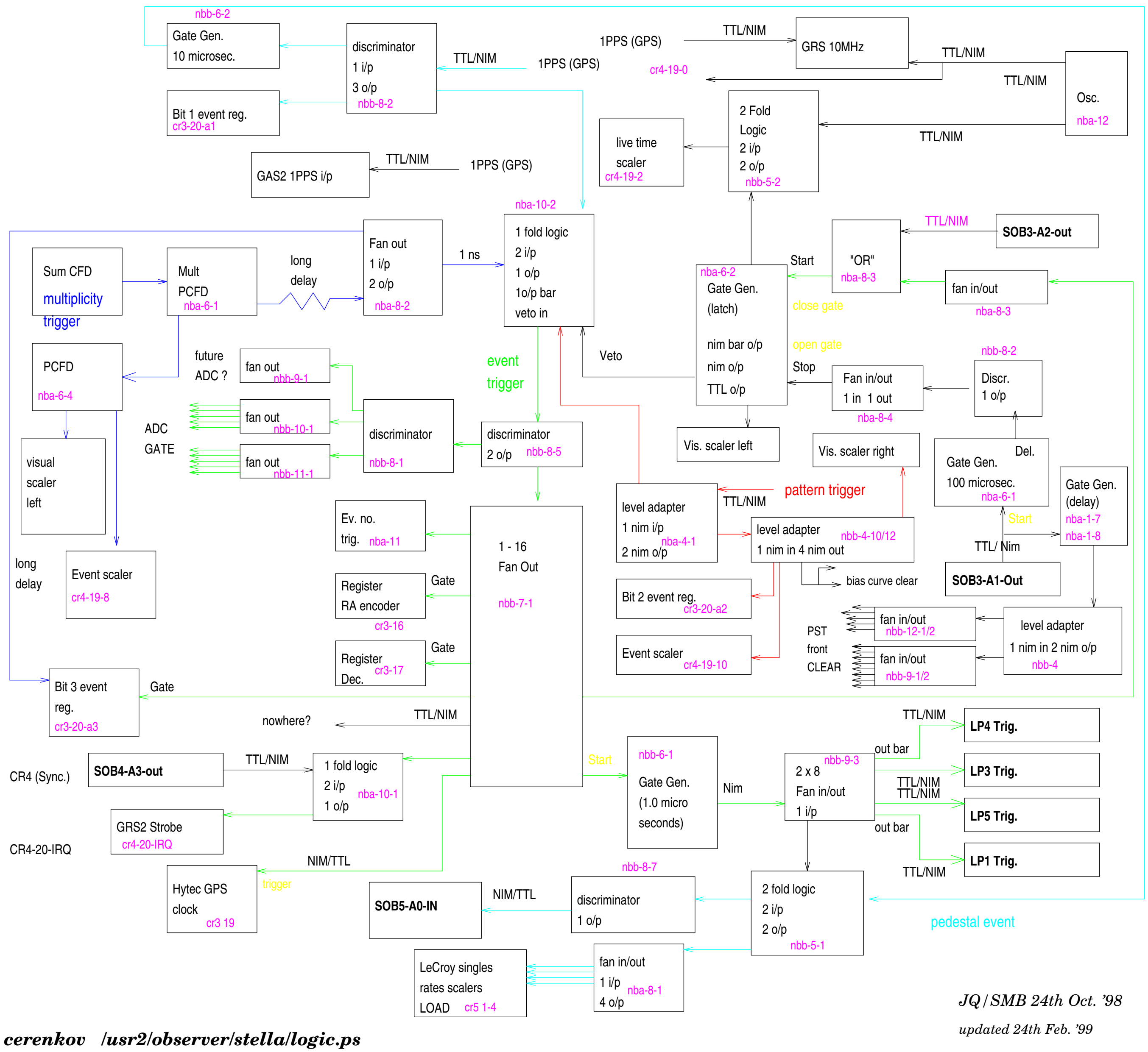

Figure 8.1: How the PST fits into the trigger logic.

Appendix A

Weather Information

The internet provides a host of information servers with the latest weather information and satellite photos. These can be reached by logging into cerenkov as observer and opening the bookmarks for weather. listed there are several sites for current pictures and movies of the weather. You can check the current humidity, temperature and wind speed on the Web at the following address, *http://lcipc/*. This page will also give you the weather trends over the last few hours. Additionally, the National Weather Service provide a forecast for Santa Cruz county on the Web at *http://www.atmo.arizona.edu/UAonly/USRADCOMP.GIF* and *http://www.weather.com/weather/cities/us_az_amado.html*.

Appendix B

X Ephemeris

Currently located on *track10* is an X-Windows ephemeris program.

The program is called */usr/local/bin/xephem*.

(1) Back at the main menu, select `100000` for the `N Steps` option (this sets up continual updating), and set the `Pause` for `30` seconds. Select `Update` to implement these options.

(2) Select `View`, then `Sky View` to set up a view of the sky. This can be resized to fit the screen appropriately.

(3) Select `Objects` from the main menu and then an object to find, track etc.

(4) Click on any object on the sky view with the R.H. mouse button to get information about the source and set up a trail behind it, or set the view tracking on it.

Appendix C

Visitor Information

For a full description of the facilities available, please obtain the FLWO User's Guide and telephone list from one of the following people: [redacted],[redacted] or [redacted].

Here are some of the most important items regarding your observing run. Many of these are geared for the first time observer.

C.1 Transportation

To/from the airport to the Basecamp via taxi. At least one day prior to requested service, call [redacted], [redacted], (520) [redacted]. Fare, effective 02/98, is $45.00 each way. The trip from the airport to FLWO includes a stop for groceries (a recommended stop is the Safeway store just west of I-19 at the Continental Road exit (Exit 63)). [redacted] can make your reservations if asked, but you must confirm with her. Cancellations are the responsibility of the traveler. Uncancelled taxi service reservations will be billed and collected from the traveler. The taxi service is a small business that provides a valuable service to the observatory, thus it is in our best interest to show them courtesy.

We currently have one other small business taxi service. [redacted], 602-[redacted]. Same price and same procedure for obtaining service.

The observatory has no food service, so you must buy provisions before arriving at the Base Camp. Fully equipped kitchens will be at your command, and staples such as coffee, flour, margarine and condiments are supplied. Soft drink machines are available also.

FLWO Shuttle Service from the Basecamp to the Mountain - Vehicles are available for transportation to and from the mountain at the times listed below. DO NOT leave the Basecamp before the listed time. Valid state or international driver's licenses are required.

If you do not drive at all, please arrange in advance for your transportation up and down the mountain.

Day Shuttles:	Leave Basecamp	Leave Ridge
	08:30 am	04:20 pm
	11:00 am	By arrangement

Evening Shuttles (Daily):	Month	Leave Office	Leave Mtn
	Jan	04:15 pm	08:00 am
	Feb	04:45 pm	07:30 am
	Mar	05:15 pm	07:00 am
	Apr	05:45 pm	06:30 am
	May	05:45 pm	06:00 am
	Jun	06:15 pm	05:30 am
	Jul	06:15 pm	06:00 am
	Aug	05:45 pm	06:00 am
	Sep	05:15 pm	06:30 am
	Oct	04:45 pm	07:00 am
	Nov	04:15 pm	07:30 am
	Dec	04:15 pm	07:30 am

Gate Lock — The current access road gate lock combination, which is also that of the Basecamp itself, is [redacted]

C.2 Dorm Reservations

Reservations are made through the basecamp with Ginnee Larson preferably a week or more in advance. You can e-mail her at [redacted] call her at (520) [redacted]. Make sure you receive a confirmation. Reservations will not be made automatically, but scheduled observers have the right to a room in the dorm nearest their telescope during their scheduled nights. An accommodation fee of $40 per person per night is charged to visitors using sleeping facilities on Mt. Hopkins. Check with Ginnee Larson to see if the fee applies to you. Here are the more detailed reservation priorities:

(1) Two observers per telescope are entitled to rooms near their telescopes during the scheduled nights.

(2) Engineers and day workers.

(3) Observers arriving before the start of their run.

(4) Official visitors.

(5) Additional observers.

(6) Other visitors and families.

C.3 Clothing

Bring warm clothes and good shoes for winter (it does snow in southern Arizona). It is also very dry on the mountain, so you might wish to bring lip balm and hand lotion, and be sure to drink plenty of fluids during your stay.

Appendix D

Passwords

```
 ----------------------------------
| draco   |   observer  |  [redacted]  |
| draco   |   root      |  [redacted]  |
 ----------------------------------
| taurus  |   observer  |  [redacted]  |
| taurus  |   system    |  [redacted]|
 ----------------------------------
| track10 |   observer  |  [redacted]  |
| track10 |   root      |  [redacted]  |
 ----------------------------------
```