PreCam User's Guide† (Draft - Version 2.0)

Adam J. Sypniewski
(ajsyp@umich.edu)

updated‡ by Wolfgang Lorenzon

University of Michigan
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Contents

† A copy of this document can be found at http://sites.google.com/site/precamsurvey/home/precam-users-guide together with the source files (in attachment section).

‡ Updates take into account changes due to the new SISPI version and the ObStac software that were installed in November.

Remarks

Parts of this manual were taken from Pat Seitzer’s “Curtis-Schmidt Telescope Operations Guide.” You should refer to Pat’s manual for instructions on initializing and shutting down the telescope each night.

1 Computer Control

1.1 Basic Info

The telescope can be controlled using the computer shown in figure 1. There are two computers called `precam1` and `precam2`. Usually, `precam1` will be used; however, if `precam1` fails, the peripheral devices (monitor, ethernet, etc.) can be moved to `precam2` instead.[1]

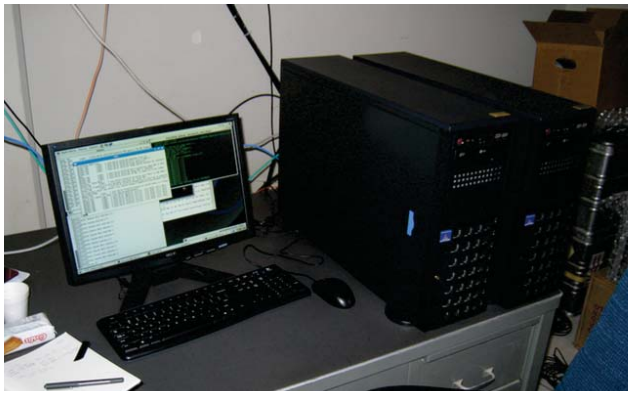


Figure 1: The primary computers used for controlling the telescope. The `precam1` computer is on the left; the `precam2` computer is on the right.

Log onto the computer with the user name and password. The directories of interest are:

`~`	The `precam` user home directory containing the `setup_sispi_cs` script for launching SISPI, `ds9` for viewing image files, and the `eups` version management system.
`~/tcs`	Contains the `tcsclient` script for controlling the telescope, and several useful scripts for taking multiple images (see Appendix D for a list of those scripts).
`~/tcs/dfmtcsdes`	Contains Perl scripts for performing common telescope tasks during start-up, shut-down, and maintanence.
`/data1/images`	Default directory to which newly made images are saved (assuming you are using the `precam1` computer).

When using the control computer, we recommend taking advantage of the multiple workspace (desktops) located in the lower-right corner of the screen. You can click on the different boxes to switch workspace, or press `Ctrl-Alt-Left Arrow` or `Ctrl-Alt-Right Arrow`.

[1] In terms of network name resolution (for SSH, etc.) the `precam1` computer is called `ctiozw`. `precam2` has a similar, but different, name. Note that some of the configuration settings are different on `precam2`, so if it becomes necessary to use `precam2`, you may need to modify these instructions.

1.2 Starting SISPI

To start SISPI, open a new terminal and type:

```
> cd ~
> source setup_sispi_cs
```

IMPORTANT: The **only** way you should **ever** exit SISPI is to select the **original** terminal window that you started SISPI with, and then press `Ctrl-C`. Trying to close it in any other way (such as just "X"-ing out of the original window or closing any/all of the SISPI child windows) will result in a dirty close.

Starting SISPI will open a great multitude of windows, and it will take a little while to start. The most important windows are PanVIEW_debug, OCS, Shutter, and the CONSOLE; the others can be **minimized** (*not* closed) if they are in the way. SISPI is loaded and ready to go once the PanVIEW_debug window shows "detext is now 1." After SISPI is ready, enter the following into the CONSOLE window:[2]

```
> configure
> pan set ccd_vsub_enbl=1
> pan set sl5_ccd_adcoffsets -5.0      (this is SL5 and not S15)
> pan set geometry overscan 50
> pan set geometry yoverscan 50
```

The `ccd_vsub_enbl` command enables the CCDs. The `sl5_ccd_adcoffsets` command changes the DC voltage offset on the CCDs (to reduce noise). The `overscan` and `yoverscan` commands choose the number of CCD rows and columns to use as overscan lines.

1.3 Using LabView

Important camera/suhtter information can be read off in LabView. This includes the duration of the current exposure, shutter status, the dewar temperature, and the dewar pressure. To launch LabView, enter the following command at a terminal window:

```
> labview
```

Then, from the LabView window that appears, go to the "Operate" and choose "Debug Application or Shared Library." A dialog window will pop up. Enter `169.254.110.160` as the IP address and then click "Refresh." You should see `startup.rtexe` appear in the "Application or shared library"

[2]Note that commands entered in the CONSOLE are sent directly to OCS, unless they begin with `pan`, in which case they are sent to PanVIEW instead.

box. Click “Connect.” After a moment, the shutter server window should appear as in figure 2.

Figure 2: The LabView shutter server. “Exposure Setting” displays the total duration of the most recent, non-zero expose command. “Active Exposure” shows the current amount of time the shutter has been open for during an on-going exposure. The “PreCam Shutter Open” light is bright green when the shutter is open.

IMPORTANT: To exit the LabView shutter server, you should **right-click** anywhere in the window, and choose “Remote Debugging” → “Quit Debug Session” from the popup context menu. You can now terminate LabView in a normal way.

Note that only one instance of LabView can be run at a time. You will receive an error message in the event that you try to start two instances. This mostly becomes a problem when using remote login.

1.4 How to Observe

Observing requires two steps:

1. Moving the telescope to the right position.
2. Taking the correct sequence of exposures.

The Curtis-Schmidt Telescope Control System (TCS) is independent of SISPI, which handles the data-taking for PreCam. A suite of Python scripts have been written, some of which communicate with both TCS and SISPI, others of which only communicate with one or the other. ObsTac-generated observations have been completely automated. So, for example, one can run

```
> python stripe82_obstac.py
```

and it will tell the TCS to move and then tell SISPI to take images. These scripts read in a `.txt` file which must be prepared separately. The scripts tell the telescope where to move and what filter to set, and then tell SISPI to take certain exposures. Within the Python script, the `FILE` variable shows what `.txt` file is utilized by that script, e.g. `FILE = "queue_as_tsv_5.txt"` is currently what `stripe82_obstac.py` is set to read. `queue_as_tsv_#` are the files that are generated by ObsTac and contain a list of tab-separated values. Python scripts which handle ObStac input should **not** be edited, except for the input `FILE` (which can be modified as necessary for each night's observations).

A plethora of other scripts are designed to take exposures but do **not** put the telescope in the right position. The first category of these are utility scripts (for details see Appendix D). Examples include: bias_frames2.py, for taking bias images (scope position is irrelevant); dark_frames2.py, for taking dark images (telescope position is irrelevant); flat_field2.py, for taking flat field images (telescope must be moved to domeflat position first); flat_ptc2.py, for taking a photon transfer sequence (telescope must be moved to domeflat position first); focus_sweep2.py, for taking images at a variety of focus settings (telescope must be moved to appropriate source first). Each of these scripts runs off of a separate `.txt` file with its own required input fields that do not necessarily match those of another script. New text files can be created, and the `FILE` variable in the Python script set, as needed. In general, if multiple versions of a Python script exist, the one labeled `*2.py` is more recent and thus more accurate for the existing commands.

To move the telescope into the appropriate position for these scripts, the coordinates must be entered into the TCS console and the slew command executed (see section 1.5 for detailed instructions).

In addition to the utility scripts, there is a library of scripts that are designed for specific targets, usually standard stars. These write all the appropriate headers for the target in question and, like other scripts, get their observing instructions from the corresponding `.txt` file but do not themselves move the telescope into position. Examples include: bd17.py, cdfs.py, dls0520.py, e28.py, sa95d.py (see Appendix D.1).

The type of script that moves the telescope and then waits for the observer to take exposures via the OCS interface is not commonly used any longer. Examples of this include tcsmulti2.py. Although the code functions currently, is not detailed here any longer.

The final important script is tcsclient.py (or tcsclientdr.py, with very similar functionality). If AND ONLY IF you are familiar with the internal workings of the Curtis-Schmidt TCS, you can send commands in "TCS format" directly to the TCS computer (this script is actually what translates all of our focus, filter, move, etc. commands into the appropriate format).

1.5 Moving the Telescope

The TCS can be operated from the console either downstairs or upstairs. Assuming everything is properly set up (see Curtis-Schmidt Nightly Startup), all commands will be issued from the TCS GUI. Under Telescope/Movement, there are options for `Slew`, `Offset`, `Object Library` and `Mark/Move`. The latter two are useful for known objects (e.g. zenith stars–see Curtis-Schmidt Nightly startup–or NGC/Messier objects). The first two are how we do most of our movements (those not contained within a Python script, at least). Under the `Slew Position` tab, `RA` is entered in HH:MM:SS and `Dec` is entered in DD:MM:SS (as labeled). Once the desired position is entered, click `Apply`, and the entered position should show up in the `Next Object` row of the main TCS window. To move, click `Start Slew`. To cancel the next object entry, click `Stop` (as is done with pointing initialization–see Curtis-Schmidt Nightly Startup). `HA` and `Dec` slews are also allowed, provided tracking is turned off first. If not, the telescope will never finish slewing, because tracking will keep it from settling at an `HA` value. Also note that going from 59 to 0 in Min will increment the Hours/Degrees, and going from 59 to 0 Sec will increment Min!

Under the `Offset` tab, offsets are in arcseconds, with positive `RA` moving the telescope east and positive `Dec` moving the telescope north. On the image display `ds9`, north is *up* and east is *left*. If you want to move a star up in the field for subsequent exposures, the telescope must be offset *down*. If you want to move a star left in the field for subsequent exposures, the telescope must be offset *right*.

1.6 Taking Images

Once the telescope is in position, you can take single images using the OCS console in SISPI[3]. If you take multiple images, we recommend the use of Python scripts instead (see Appendix D.1). Before issuing exposure commands, you need to set the exposure time and exposure type

```
> set exptime X
> set expType='name'
```

where "X" is the exposure time in seconds, and "name" the exposure type that can be either "object", "bias", "flat" or "dark". Now you can execute the exposure command

```
> expose X,Y,Z
```

where "X", "Y", and "Z" can be various comma-separated parameters such as "count", "RA", "dec", "note", and "filter". For example, to take two images with a right ascension of 30.9, a declination of -30.9, in the 'r' filter and a note of '47 Tuc', you enter

```
> expose count=2,RA=30.9,dec=-30.9,note='47 Tuc',filter='r'
```

To take a zero second image with the shutter closed (known as a *bias*), enter:

```
> set expType='bias'
> expose
```

Once you send the expose command, the PanVIEW console windows should display activity. You can see the status of the shutter in the LabView shutter server window. After exposure is done, the image must be processed. Once the image is fully processed and ready for viewing, you can check the image number in the DHS1 console in case you lost track (these image numbers are sequentially generated by SISPI) and you can view the image using `ds9` (see section 1.7 for more information).

[3]These commands have changed significantly with the installation of the updated SISPI.

If you notice your image has saturated regions, the CCDs may have built up excess charge due to dark currents. This charge build-up is cleared when the CCD is read. Thus, if you just took an image and this is the case, simply take the image again. If it has been some time since your last exposure (say, 15 minutes), you may want to thwart this charge build-up by *clearing* the CCDs. You can achieve this by simply taking a "throw-away" image; a zero-second dark image (called a *bias*) is sufficient.

1.7 Viewing Images

Once an image has been taken, it is saved to disk in `/data1/images`. These images can be viewed using `ds9`. To start `ds9`, enter the following at a terminal:

```
> cd ~
> ./ds9
```

The `ds9` program will start. To open a file and look at both CCDs side-by-side, go to the "File" menu and choose "Open Other" → "Open Mosaic WCS...". You will need to navigate to the appropriate directory (usually `/data1/images`) and select the image of interest. Once an image is loaded, you can zoom, rescale the intensity, etc., using the toolbar buttons. There is no special procedure for closing `ds9`.

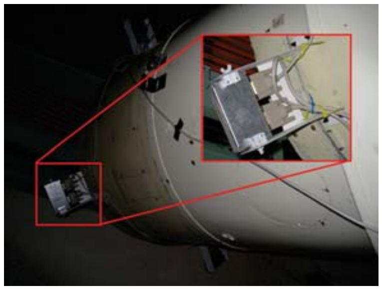
2 Dome Flats

To take dome flats, first ensure that the dome and hatch are both closed. Make sure that there is nothing in the way of the telescope and that the main optics cover (section 7.2) is off. You may need to move the telescope to the service position (section 3) to remove the optics cover. Open a new terminal and execute the command

```
> domeflats
```

The `domeflats` command is a Perl script which turns off rate correction and telescope tracking, sends the dome to 270° azimuth (west), and points the telescope at the flat-field (east). You will hear the TCS box in the "darkroom" beep when the telescope is in position. You should now verify that the telescope is, in fact, pointing at the flat-field screen. If it is not, use the handpaddle (section 7.3) to correct the telescope position.[4] Turn on the flat-field illumination system (figure 3) by flipping the power switch to the ON position. Ensure that all of the LED switches are ON except for the 810nm switch (it is too bright). Note that the direction of the ON position for each switch is the same as the main power switch. You should see the LEDs illuminating the flat-field screen.

[4] If the telescope is consistently mis-aligned, you can take note of the correct HA and DEC and modify the Perl script.



(a) Location at end of barrel

(b) Front, showing LEDs

(c) Control box; the 810nm on/off switch is marked in red

Figure 3: Flat-Field Illumination System. Note that there are a total of 4 illumination boxes at the end of the telescope.

You should consult the PreCam observing plan/commission tests for dome flat measurements. You may need to clear the CCD first. See section 1.6 for information on taking images.

If you performed dome flats in the order of the "Nightly Checklist" (section A), then you can stop here. Otherwise, if you want to leave the dome flats position and continue observing, issue the following commands to turn on dome tracking, rate correction, and sidereal tracking:

```
> dome on
> track on
```

Alternately, you can use the `tcsclient` script to prepare the telescope for observing:

```
> cd ~/tcs
> python tcsclient.py "#21,0;"
> python tcsclient.py "#19,1;"
> python tcsclient.py "#14,15.041,0.0,0.0,0.0;"
```

3 Service position

To send the telescope to the service position, we need to return the dome to home (90° East), turn off rate correction and sidereal tracking, and send the telescope to the service position. This can be done using the `dfmtcsdes` scripts (see section 1.1):

```
> service
```

Alternately, you can send the telescope to the service position by using the `tcsclient` script:[a]

```
> cd ~/tcs
> python tcsclient.py "#21,1;"
> python tcsclient.py "#19,0;"
> python tcsclient.py "#14,0.0,0.0,0.0,0.0;"
> python tcsclient.py "#30;"
> python tcsclient.py "#12;"
```

[a] Refer to section B.2 for more information.

You will hear the TCS box in the "darkroom" beep when the telescope is in position.

If you want to leave the service position and continue observing, you can issue the following commands to turn on dome tracking, rate correction, and sidereal tracking:

```
> dome on
> track on
```

Alternately, you can use the `tcsclient` script to prepare the telescope for observing:

```
> cd ~/tcs
> python tcsclient.py "#21,0;"
> python tcsclient.py "#19,1;"
> python tcsclient.py "#14,15.041,0.0,0.0,0.0;"
```

4 Evacuating the Dewar

In order to ensure that water condensation does not impede camera operation, a balance must be struck between dewar temperature and pressure (to keep the CCD above the dewpoint). The target temperature is 173K (-100°C). The target pressure is below 90μTorr. If the pressure is above 90μTorr, or if you believe it will exceed 90μTorr during the night's observing run, you need to evacuate the dewar, following these directions.

IMPORTANT: The PreCam CCD is extremely sensitive to electro-static discharge (ESD). Always take appropriate precautions before servicing the camera. The exposed, braided cable on the telescope is grounded. Also, once you turn on the pump, the pump should not be moved or tilted until the turbo-pump has fully stopped and the power is off. Furthermore, we are not fully aware of how PreCam's pumping cycle is going to work; therefore, be aware that the frequency of pumping may be more or less often than you expect.

1. Make sure the telescope is in the service position (section 3).

2. Bring the pump (figure 4a) near the camera and make sure the pump is off. Note that the metal cylinder protruding from the top of the pump is a turbo-pump.

3. Attach the vacuum hose to the pump if it is not already attached. If you need to attach the hose, do the following:

    (a) Unscrew the clamp on the top of the turbo-pump

    (b) Set the blank-off aside. The blank-off is a metal disk which acts as a cover for the vacuum pump. The clamp was previously holding it in place.

    (c) Place the hose over the hole to the pump, making sure that the O-ring is between the pump and the hose.

    (d) Reattach the clamp and tighten it as tightly as you are able by hand. Make sure that the washer is touching the wingnut.

4. Be sure that you, the pump, and the vacuum hose (the top of the pump is electrically isolated from the rest of the pump) are grounded to avoid any ESD damage to the camera.

5. Close the pressure valve (figure 4b) on the camera.

6. Attach the vacuum hose to the camera. This is done in a similar manner as listed above. Make sure the vacuum clamp is as tight as you can turn it.

7. Make sure the black relief valve, located on the back of the turbo-pump, is fully closed.

8. Plug the pump in and press its power switch to turn it on.

9. Press the right-arrow button on the pump until 309 appears on the screen. This is the speed of the turbo-pump.

10. Press the turbo-pump on/off switch. It is the right-most button of the four buttons near the display. This will turn the pump on.

11. The turbo-pump must reach its maximum speed of 1500Hz before the pressure valve on the camera is opened. Once the pump reaches 1500Hz, open the pressure valve.

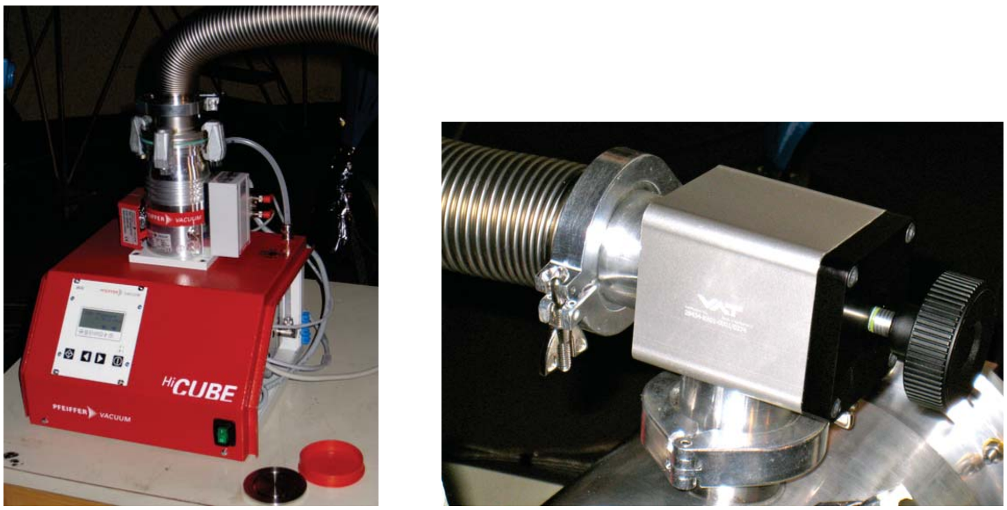
12. The pressure should begin dropping. You can monitor the pressure using LabView. When the pressure is sufficient for completing the observing run, close the pressure valve.

13. Turn the turbo-pump off by pressing the right-most switch of the four near the display (**not** the power switch).

14. Wait until the turbo-pump speed is 0Hz. You may then open the relief valve and turn the pump off (green power switch).

15. Remove the vacuum hose from the camera. Reattach the blank-off using the O-ring and clamps Be sure the clamp is as tight as possible using your hands. Place the plastic cap back on the exposed end of the hose. You may leave the hose attached to the vacuum pump.

16. Unplug the pump and put it away.



(a) Vacuum pump with hose attached. The power switch is the green switch in the lower-right. The right-most button near the display is the turbo-pump on/off switch. The blank-off and cap are in the lower-right.

(b) Pressure valve on the camera with hose attached. The valve is the black knob on the right

Figure 4: Vacuum pump and pressure valve.

If PreCam doesn't seem to achieve the desired pressure (note that it may take several hours before you know how low the pressure will go), then pump it as low as possible, following the evacuation directions. Once the pump is disconnected and put away, check the pressure in LabView. You now need to adjust the heater (section 6.7) so that the temperature is above the dewpoint. Consult table 1 to determine the dewpoint, which is the lowest temperature you can adjust the heater to.
For example, if the lowest pressure you are able to pump the dewar down to is 4000μTorr, then the lowest temperature you can set the heater to is $-80°$C (because, from the table, you aren't allowed to go to $-90°$C until you've achieved a vacuum pressure of 1000μTorr).

Dewar Pressure (μTorr)	Dewpoint (°C)
100	-100
1 000	-90
5 000	-80
20 000	-70
100 000	-60

Table 1: Dewpoint temperature at a given pressure.

5 Focus and Filter

5.1 Focus

The camera focus can be changed over a range of 10mm (10,000μm). To change the camera focus, issue the commands

```
> cd ~/tcs
> python tcsclient.py focus move X
```

where "X" is the desired focus position measured in microns, and can range from 0 to $10,000$. 0 moves the focus in, and $10,000$ moves the focus out. If you move the focus, you should always verify its position using

```
> python tcsclient.py focus status
```

This will return the current position of the camera focus. If this returns "active," then the focal plane is still moving. If this returns "ok," then the focus is ready.

Alternately, you can verify the focus in hardware by referring to the focus dial near the camera (see figure 5 for details).

The best focus is usually between $7,100-7,250$. You should be aware that for warmer temperatures the best focus value tends lower.

5.2 Filter

The PreCam filter changer has five DES filters: g, r, i, z, and Y. If you are using the `multi_tcs` script, then filter changing is done for you. If you need to switch filters manually, enter

```
> cd ~/tcs
> python tcsclient.py filter move X
```

where "X" is the number corresponding to the desired filter: 1 for g, 2 for r, 3 for i, 4 for z, and 5 for Y. If you issue the `filter move` command, you should follow up with a status check (this command can also be used to verify which filter is currently in place):

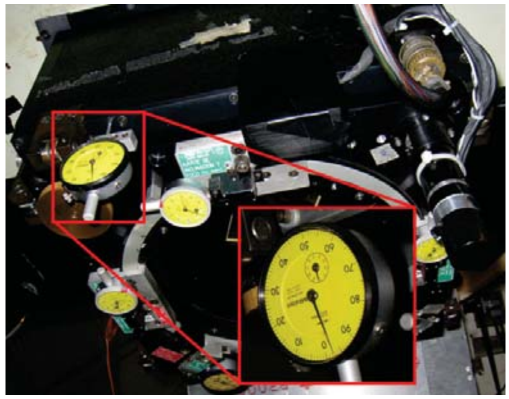


Figure 5: Focus dial shows position of focal plane. It is located on the tilt-and-focus box opposite the camera. Note that the camera is not attached in this picture. The small dial is in millimeters. Ticks on the large dial are in units of 10μm.

```
> python tcsclient.py filter status
```

Continue issuing this command until it returns "ok," which indicates that the filter is in place. If it returns "active," the filter changer is still moving.

Alternately, you can verify the current filter in hardware. At one end of the filter changer (section 6.2) is a large, protruding cylinder. Near it is a small knob with "open" and "closed" positions (figure 6). This knob prevents light leakage during exposures and should normally be kept in the "closed" position. To check the filter status, turn the knob to "open" and shine a flashlight in the hole next to the knob. If you look carefully, you will see a number which corresponds to the currently selected filter. Be sure to move the knob to the "closed" position when you are done.

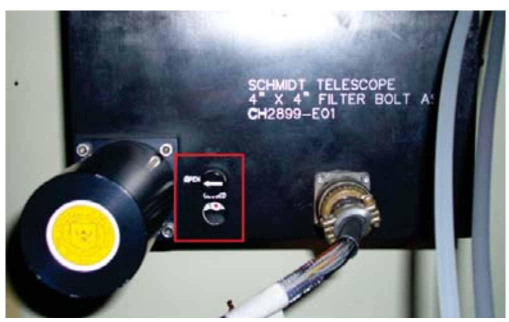


Figure 6: The filter status hole on the filter changer mechanism.

Once the filter is in place, the telescope status has been verified, and the telescope coordinates are correct, you are ready to take images (see section 1.6 for information on taking images). For more information on using the `tcsclient` script, see section B.1.

6 PreCam Components

6.1 Camera

The PreCam camera (figure 7) attaches to the tilt-and-focus box on the side of the telescope. It contains two CCDs. These CCDs are extremely sensitive to electro-static discharge (ESD); proper caution must be taken when handling/touching the camera. It is held in place by four, small, yellowish-gold clamps.

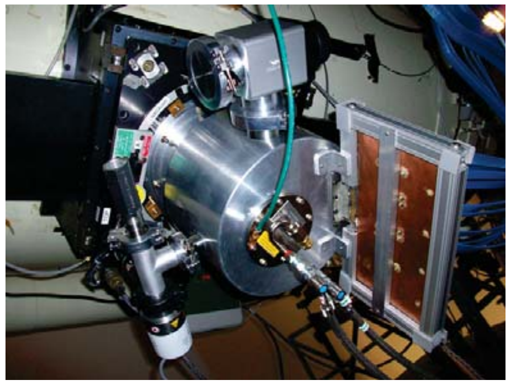


Figure 7: PreCam. Two of the mounting clamps are visible. The pressure valve and vacuum intake are visible at the top of the image. The VIB board is the copper rectangle on the right. The pressure gauge is the off-white cylinder in the lower-left. The cooling lines are attached in the center of the back of the camera. The green grounding cable attaches to the telescope ground.

6.2 Filter Changer

The filter changer (figure 8) holds the five DES filters (g, r, i, z, and Y). It is a long, thin, rectangular box located on the telescope in front on the camera. It is controlled by the focus and filter box (section 7.1). To change the active filter, refer to section 5.2.

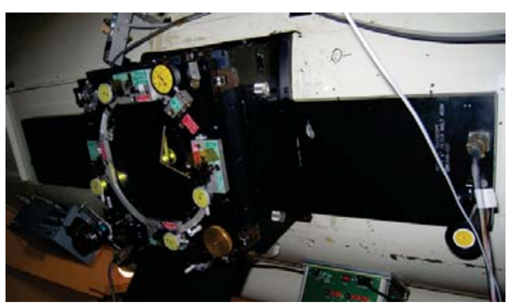
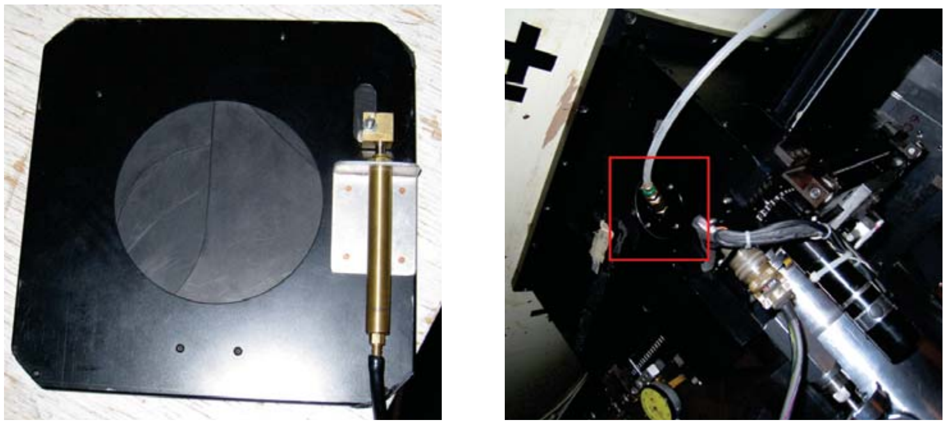


Figure 8: Filter changer. The camera is not attached in this picture.

6.3 Shutter

The shutter (figure 9a) attaches to the front of the camera. A pneumatic hose **screws** into the bottom of the shutter, is fed through the black tilt-and-focus box (figure 9b), and attaches to the shutter gas solenoid (section 6.5).



(a) Camera shutter. The pneumatic host is attached in the lower-right.

(b) Tilt-and-focus box, showing where the pneumatic hose emerges.

Figure 9: Shutter and Hose

6.4 Monsoon Crate

The monsoon crate (figure 10a) contains the CCD readout electronics. The power should *always* remain on.[5] It is located on the side of the telescope shaft. The blue cables connect to the camera's VIB board (figure 10b).

6.5 Shutter Gas Solenoid

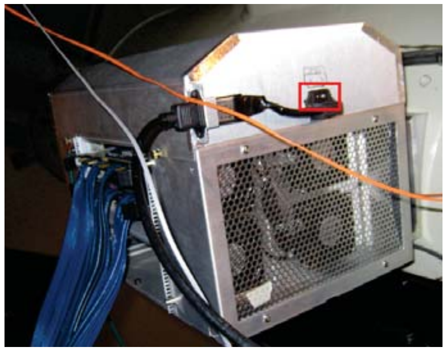
The shutter gas solenoid (figure 11) is responsible for causing the shutter to open and close. It is located on the back of the monsoon crate, and is triggered by a signal from the shutter module on the power supply box (section 6.8). One pneumatic hose runs through the tilt-and-focus box to the shutter (section 6.3), and the other runs to the shutter gas cylinder (section 6.6).

If the pneumatic hose needs to be detached in order to remove the camera and shutter during maintenance, push the green ring in while pulling the hose out. To reinsert the hose, just push it in.

6.6 Shutter Gas Cylinder

The shutter gas cylinder (figure 12) controls the gas flow to the shutter gas solenoid. At the beginning of every night, the tank should be opened (the silver, octagonal knob) and the flow valve

[5]Although the monsoon crate should never be turned off; however, if it needs to be turned back on after maintenance, it may take up to twenty minutes to communicate with SISPI again.



(a) Monsoon crate. The power switch is marked is red.

(b) Blue monsoon crate cables connect to the green VIB board.

Figure 10: Monsoon crate and VIB board.

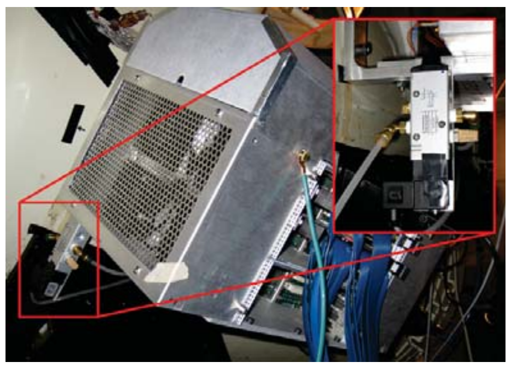


Figure 11: Shutter Gas Solenoid. The inset image shows the pneumatic hose which attaches to the shutter coming out of the solenoid on the left-hand side. This hose is disconnected in the main image.

should be opened (the small black, round plastic knob). At the end of every night, these two knobs should be shut off. The regulator (metal bar with gauge attached) should **not** be adjusted. The pressure should always read 42psi when using the telescope.

6.7 Heating and Cooling System

The heater and compressor are located on the floor of the control room (figure 13). The compressor is sitting on the floor; the Lake Shore heater unit is located on top of the compressor. The power switch for the compressor is located on the right side of the unit. The power switch for the heater is on the back of the unit. Both of these units should **always** remain on.

The sensor temperature is shown on the top of the heater display, and the setpoint (target) temperature is shown on the bottom of the display. Both temperatures are given in units of Kelvin. Due to a sensor miscalibration, all displayed temperatures are 23°C **less** than their actual values. Thus,

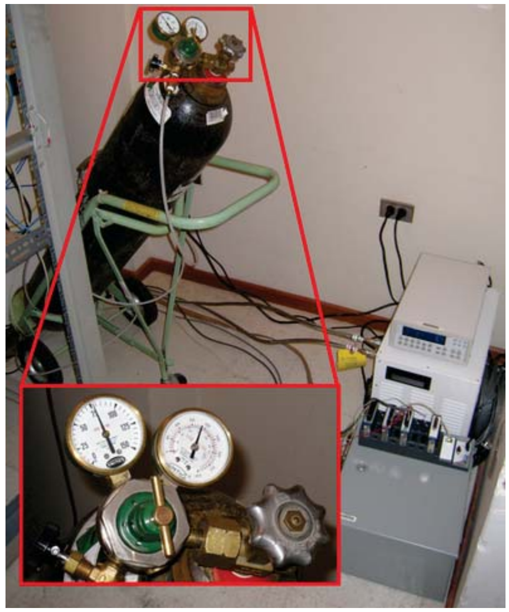


Figure 12: Shutter Gas Cylinder

if the sensor temperature reads 255.41K, then the actual dewar temperature is 232.41K. Similarly, if you want the set the dewar temperature to 240K, you should input a setpoint temperature of 263K.

> IMPORTANT: Although the heater unit has a sensor miscalibration and requires that you consider the 23°C offset, the LabView shutter server (section 1.3) has accounted for this. Thus, the temperature displayed in LabView is always the **true** temperature.

Ideally, you shouldn't need to change the heater settings. However, if it is necessary to change the setpoint (target) temperature, press the "SETPOINT" button (button number 6). Then enter the desired target temperature (taking into account the offset) and press "ENTER." Now, you still need to enable the heaters. To do this, press "HEATER RANGE." Then press the "up arrow" until "High" is displayed. Then press enter. The heater is now ready.

6.8 Power Supply Box

The power supply box (figure 14) is located on the floor on the control room in front of the compressor. Its sole purpose in the current configuration is to provide a 24V signal to the shutter gas solenoid (section 6.5) during an exposure.

On top of the power supply box are three modules. Two are used for reading off the pressure and temperature of the camera dewar. The third triggers the shutter during exposure.

Figure 13: Heater and Compressor. The power supply box and control modules are visible in the foreground.

7 Telescope Components

7.1 Focus and Filter Box

The focus and focus box (figure 15) is responsible for interpreting the focus commands. It is attached to the side of the telescope shaft. To change the active filter, refer to section 5.2. To change the camera focus, refer to section 5.1.

7.2 Optics Cover

The main optics cover protects the telescope from damage. It covers the end of the telescope. To remove it, you will likely need a step stool. Carefully remove it, being aware of the flat-field illumination system (figure 3). It can be placed in the north-east corner of the dome (figure 16).

7.3 Telescope Mount

The telescope is on an equatorial mount as shown in figure 17. Hanging on the mount is the handpaddle which can perform gross telescope and dome movement. On the equatorial (RA) axis you will find the marks used for calibrating the telescope at startup.

If you want to rotate the dome, press and hold the desired “L” or “R” button at the bottom of the control (near the word “DOME”). To slew (turn) the telescope, hold down the “SLEW” button and,

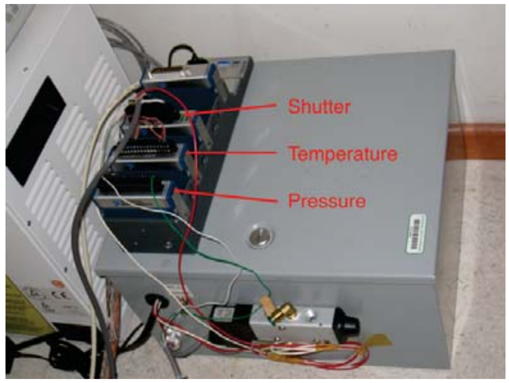


Figure 14: Power Supply Box. The pressure, temperature, and shutter control modules are also shown.

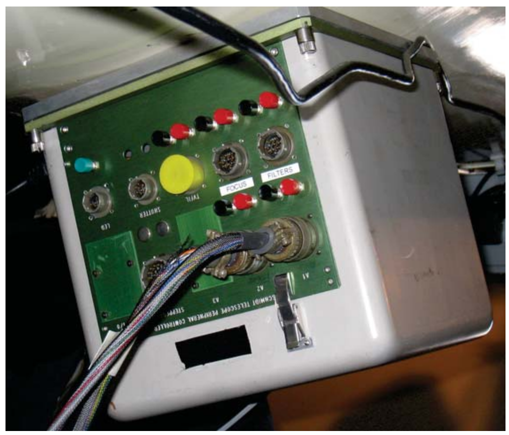


Figure 15: Focus and Filter Box

at the same time, press the direction corresponding to the desired slew direction. During telescope calibration at the beginning of the night, the relevant directions are "W" and "E."

7.4 Dome

The dome has markings on it to show if it is oriented toward 90° East. These markings are located on the west wall (figure 18b). These marks are useful when performing basic telescope calibration at the beginning of every night (they are mentioned in Pat Seitzer's guide).

If you need to rotate the dome, use the handpaddle located on the telescope mount (section 7.3).

The dome shutter control (figure 18a) opens and closes the dome. To open or close the shutter, move the switch to the respective position. Always return the switch to the "Off" position after opening or closing the dome.

Figure 16: Main optics cover sitting in the corner of the dome.

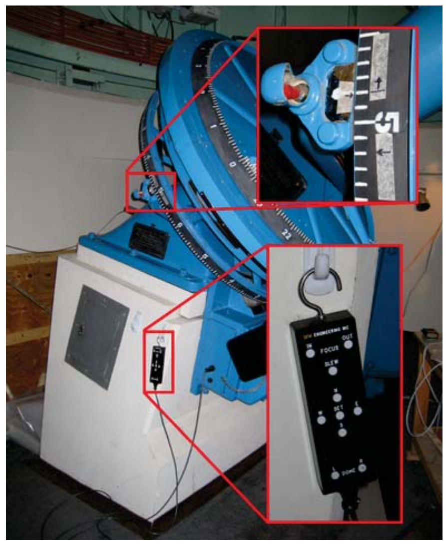


Figure 17: Telescope Equatorial Mount

7.5 Telescope Control System

The telescope control system (TCS; figure 19) controls telescope and dome movement. It is located in the left (north) wall of the "darkroom." The clock shows UTC (GMT) time. The computer (the TCS console) displays the current state of the telescope and dome. It is also used for calibrating the telescope at the beginning of the night. Many of the controls you need to verify are located on the blue TCS cabinet.

(a) Dome shutter control

(b) Dome orientation markings

Figure 18: Dome

Figure 19: Telescope Control System showing the TCS cabinet and the TCS console.

A Nightly Checklist

This checklist is an overview of what you should do every night. It is *not* a replacement for reading and understanding the other telescope guides/resources. It *is* a place to start to get acquainted with basic nightly operations. Now, onward to the nightly checklist.

1. Check that the compressor and heater (section 6.7) are on.
2. Open the shutter gas cylinder (section 6.6). Do **NOT** adjust the regulator.
3. Start LabView (section 1.3).
4. In LabView, verify that the temperature is 173K (-100°C) and pressure is below 90μTorr. If the pressure is above 90μTorr, or if you believe it will exceed 90μTorr during the night's observing run, you will need to evacuate the dewar (section 4).
5. Start SISPI (section 1.2).
6. Create a new folder in the `/data1/images` directory on `precam1`. The folder should be named with the current date in the form `YYYYMMDDUT`. Copy the log template `PreCam_template.log` from the `/data1/images` folder into this new folder and rename to a form `PreCamYYYYMMDDUT.log`. Start documenting/recording/logging everything you do into this log file.
7. Take several bias frames (section 1.6) and check them in `ds9` (section 1.7).
8. Take several dark images (section 1.6) and check them as well.
9. Remove the main optics cover (section 7.2) and check that the cables on the floor below the telescope will not be pulled too hard when the telescope moves.
10. Take dome flats (section 2).
11. Read and follow the section in Pat Seitzer's "Curtis-Schmidt Telescope Operations Guide" entitled "Curtis-Schmidt Nightly Startup." This section makes reference to several important things:
    - The TCS cabinet and TCS console (section 7.5)
    - Verifying that the dome is 90° East (section 7.4)
    - Removing the main optics cover (section 7.2)
    - Moving the telescope with the handpaddle (section 7.3)
    - Executing console commands (section 1)
    - Taking images (section 1.6). It will need to be dark enough to find a bright star.
12. At the end of the night, follow the section in Pat Seitzer's "Curtis-Schmidt Telescope Operations Guide" entitled "Curtis-Schmidt End of Night."

13. Check that the telescope is back in the service position (section 3), and replace the main optics cover.

14. Close LabView and SISPI (make sure you do it the right way).

15. Close the shutter gas cylinder (do **not** change the regulator).

16. Do not turn off the the compressor or heater.

17. Create a new folder in the `/data1/images/YYYYMMDDUT` directory on `precam1` you created earlier for the log file. The folder should be named `fits`. Move the images you took that night from `/data1/images/fits` into the new folder. (Note that the files in `/data1/images` are backups only and will be erased once all files have arrived at FNAL).

18. Upload the images by executing the following command:

    ```
    > cd ~martelli/bin
    > ./pushdir X
    ```

    where “X” is the full path to your newly created directory
    (for example, `/data1/images/20101126UT/fits`).

19. Fill out the end-of-night report and email the log file the PreCam mailing list.

A.1 Good Practice

Here we collect some remarks, in no specific order, for good practice that did not fit naturally in any of the sections in this document.

1. You should be documenting/recording/logging everything you do. It is better to write down too much than too little.

2. When going in and out of the control room, shut the door! The curtain up to the dome is not always good at blocking the light.

3. Only one window should join the SISPI instance (for details how to do this see appendixD.1). This window should be on the PreCam computer in the control room.

4. Keep coordinates straight! TCS needs decimal *hours* (except in GUI interface), FITS headers should be in decimal *degrees*. Most scripts have the value recorded in decimal hours, which is then converted to degrees before the `expose` command is executed.

B `tcsclient` script

The `tcsclient` script is a Python script which simplifies many of the non-exposure-related tasks. It is located in the ~`/tcs` directory.

B.1 "Built-in" commands

The `tcsclient` script has several useful commands you can pass it. These commands take the form:

```
> python tcsclient.py X
```

where "X" is one of the following commands.

Command	Description
getstatus	Returns the telescope status. Ideally, the return value should be `[0, 0, 0, 1, 0, 1, 1, 1]` when the telescope is ready to expose. The number of interest in the return value is the fifth entry in the array (fourth zero-based entry). If this flag is set (equal to 1), then the target is out of range (below the horizon). If this flag is not set (equal to 0), then then telescope will be able to see the target.
getcoords	Returns the telescope coordinates, including HA, RA, DEC, Airmass, etc.
filter move F	Changes to filter F. F can be one of the numbers 1, 2, 3, 4, 5 to select the respective g, r, i, z, Y filter. This command should be followed by the "filter status" command. See section 5.2 for more information.
filter status	Checks the status of the filter changer and returns the current filter. If this returns "active," then the filter changer is still changing filters. If this returns "ok," then the new filter is in place and ready to go. See section 5.2 for more information.
focus move F	Changes the focus to position F. F is the position of the focal plane measured in microns and can range from 0 to $10,000$. 0 moves the focus in, and $10,000$ moves the focus out. This command should be followed by the "focus status" command. See section 5.1 for more information.
focus status	Checks the position of the focus mechanism and returns the current focal position. If this returnes "active," then the focal plane is still moving. If this returns "ok," then the focus is ready. See section 5.1 for more information.

B.2 TCS commands

People have gone to "great lengths" to make TCS transparent to the operator. The `tcsclient` script has many useful and simple commands, and the Perl scripts in the `~/tcs/dfmtcsdes` directory (documented in Pat Seitzer's "Curtis-Schmidt Telescope Operations Guide") can greatly reduce the work of the observer. However, sometimes you need to send commands directly to the TCS. The `dfmtcsdes` scripts have examples of how to accomplish this in Perl. The `tcsclient` script, however, is already ready to send raw commands to the TCS. These commands take the form:

```
> python tcsclient.py "#X;"
```

where "X" is replaced with the appropriate TCS command number (note the semi-colon at the end of the command). If the command requires arguments to be passed, they are supplied as comma-spaced values following the command number. For example, command 30 prepares the telescope to move to the service position. Command 12 tells the telescope to actually move. Neither of these commands take any arguments. Thus, to move the telescope to the service position, enter the following at a terminal:

```
> python tcsclient.py "#30;"
> python tcsclient.py "#12;"
```

Similarly, rate correction can be toggled with command 19. It takes a single, boolean argument: 1 to turn rate correction on, or 0 to turn it off. Thus, turn turn on rate correction, issue

```
> python tcsclient.py "#19,1;"
```

A partial list of commands is:

Command	Description
6	Prepares the telescope to move to a given position in the sky (must be followed by command 12 to actually move). It takes three arguments: RA, DEC, and EPOCH. An example would be: `"#6,0.4014,-72.0817,2000.0;"`
12	Moves the telescope to a pre-determined location. You will hear the TCS box in the "darkroom" beep when the telescope is in position.
14	Toggle sidereal tracking. To turn it on, use: `"#14,15.041,0.0,0.0,0.0;"` as the entire argument to the `tcsclient` script. To turn it off, use: `"#14,0.0,0.0,0.0,0.0;"`
19	Toggles rate correction. It takes a boolean argument: 1 to enable rate correction, or 0 to disable it.

Command	Description
21	Toggles dome tracking. It takes a boolean argument: 0 to turn it off (and return the dome to home position), or 1 to turn it on.
26	Queries the telescope status. The number of interest in the return value is the fifth entry in the array (fourth zero-based entry). If this flag is set (equal to 1), then the target is out of range (below the horizon). If this flag is not set (equal to 0), then then telescope will be able to see the target. Ideally, the return value should be `[0, 0, 0, 1, 0, 1, 1, 1]` when the telescope is ready to expose.
30	Prepares the telescope to return to the service position (must be followed by command 12 to actually move)

C Moving the Telescope-The Difficult Way

If **and only if** you are familiar with the internal workings of the Curtis-Schmidt TCS, you can manually move the telescope to a single target position by entering the following, replacing `RA`, `DEC`, and `EPOCH` with the appropriate target coordinates (`RA` in HH:MM:SS, and `DEC` in DD:MM:SS)

```
> cd ~/tcs/dfmtcsdes
> slew RA DEC EPOCH
> go
```

Alternately, you can use the `tcsclient` script, replacing `RA`, `DEC`, and `EPOCH` with the appropriate target coordinates (`RA` in HH.HHH, and `DEC` in DD.DDD):[a]

```
> cd ~/tcs
> python tcsclient.py "#6,RA,DEC,EPOCH;"
> python tcsclient.py getstatus
> python tcsclient.py "#12;"
```

Command 6 prepares the telescope to move to the selected target. The `getstatus` command returns the telescope status. You should ensure that the telescope status reads `[0, 0, 0, 1, 0, 1, 1, 1]`. Pay particular attention to the fifth flag (the fourth zero-based flag) of the telescope status response; if this flag is set (equal to 1), then the target is out-of-range. Command 12 causes the telescope to actually move to the target.

[a] Refer to section B.2 for more information on using `tcsclient`.

Note that you will hear the TCS box in the "darkroom" beep when the telescope is in position. You can verify the telescope position by issuing

```
> cd ~/tcs
> python tcsclient.py getcoords
```

D Utility scripts

Several utility scripts have been created to simplify many of the exposure-related and book-keeping tasks. They are located in the ~/tcs directory. Some of those scripts might change to accommodate specific user needs. The most commonly used scripts are listed here.

D.1 Python scripts

Many of the nightly tasks, such as taking biases, dark images, and dome flats, have been simplified using Python scripts. Below you find a list of Python scripts you might find useful during calibration runs and even regular science data collection. They are stored in the /home/precam/tcs directory. Each of the python scripts has a .txt file associated with it that has a matching name. You need to check these .txt files to assure that they have the required information.

Before you run the first Python script make sure that you enter the following commands on a xterm window

```
> join_instance PCObs#
> setup SISPI
> cd ~/tcs
```

where “#” stands for whatever the current instance name is (see setup_sispi_cs).

Now you are ready to execute one of the Python scripts listed here:

D.1.1 biases

To take bias frames issue the command

```
> python bias_frames2.py
```

D.1.2 dark frames

To take dark frames issue the command

```
> python dark_frames2.py
```

D.1.3 flat fields

To take regular dome flat fields issue the command

```
> python flat_field2.py
```

D.1.4 photon transfer curves

To take photon transfer curves issue the command

```
> python flat_ptc2.py
```

D.1.5 focus sweeps

To take focus sweeps issue the command

```
> python focus_sweep2.py
```

D.1.6 stripe82 scans

To take scans of the stripe82 field issue the command

```
> python stripe82.py
```

D.1.7 various specific fields

Here is a list of various specific fields that can be covered depending on circumstances:

bd17.py	e2a.py	e8a.py
tpheb.py	cdfs.py	g158.py
2060.py	0630.py	0230.py
sa93a.py	sa95d.py	

D.2 Shell script

D.2.1 transform.s

ObStac-generated observations create many lines (from tens to several hundreds) of instructions of where to move the telescope and what kind of exposure to take. Instructions for measuring in Stripe 82, for example, are written by ObStac into files of the form `queue_as_tsv_#.txt` and read by the Python script `stripe82_obstac.py`. To help observer record the exposure time, filter setting, and RA and dec values for each observation in the nightly log file, we have written a simple shell script, `transfer.s`, that transfers the ObStac output format to the nightly log file format. The shell script needs an input file (e.g. `queue_as_tsv_7.txt`) and creates an output file (e.g. `logfile`) and is executed as

```
> cd ~/tcs
> transform.s queue_as_tsv_7.txt logfile
```

The content of `logfile` can then be copied by your favorite editor into the nightly log file. For completeness, the main content of `tranform.s` is

```
more queue_as_tsv_7.txt|awk '{printf"4000\t\t\t%3.0f\t%s\t%6.2f\t%6.2f\t\n",$4,$3,$1,$2}' >> logfile
```

Although it should not be necessary to modify `tranform.s`, you should only edit it if you are familiar with shell script and awk.

E Printing

Compiling this document in latex produces a `.PDF` file that is approximately 15MB big, because the `.PNG` files have much larger resolution than necessary. If `Adobe Acrobat` is installed on your Windows based PC (or laptop), you can print the `.PDF` file to the "Adobe PDF" printer and therefore reduce the `.PDF` file size to approximately 600kB.

The only printer currently available to PreCam is the Lexmark T644 printer on the ground floor of the Blanco telescope (IP address is `139.229.13.80`). There is no printer queue installed on the PreCam computers. So this document must (currently) be printed from a laptop computer with the Lexmark T644 printer installed.

On a Windows machine, you set up the printer using the "Add a Printer Wizard", and choosing "Local Printer attached to this computer". Under "Select a Printer Port", choose "create a new port" and "Standard TCP/IP port", and follow the Wizard that pops up.

On an Apple Mac, the print settings for the Lexmark printer are
address: `lpd://139.229.13.80`/
name: `CTIO4m-npt0`

You can also find a "CTIO printers HowTo" at
`http://www.ctio.noao.edu/sys/printers.php`.