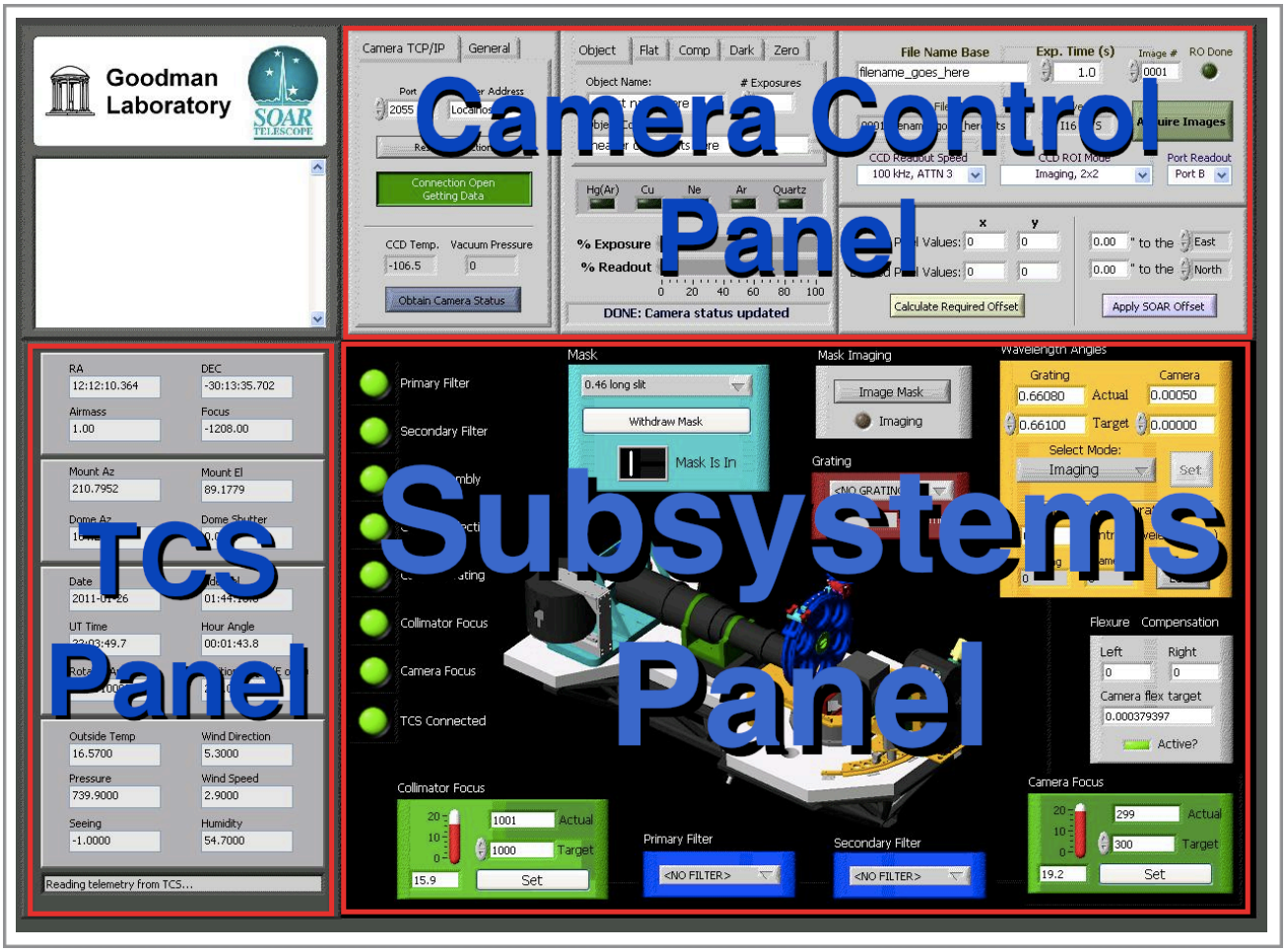
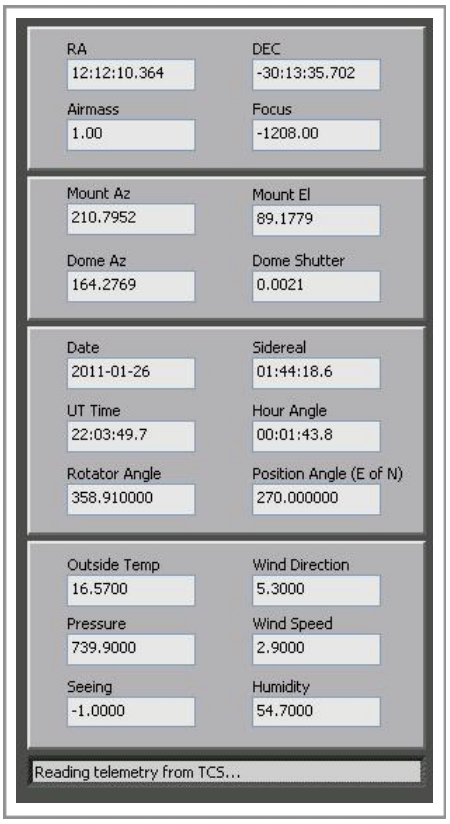
Layout of the Goodman Spectrograph Control System (GSCS)

1. General GUI Overview

The main GUI of the GSCS is shown below and consists of three major panels: the ***TCS Panel*** (left), the ***Subsystems Panel*** (bottom right), and the ***Camera Control Panel*** (top right). A model of the spectrograph is shown at the center of the *Subsystems Panel* with components colored to match those of the subpanels that control them. The positions of the grating and camera in the model will update to mimic their actual configurations while observing. Details on each panel follow.



2. The TCS Panel



The Telescope Control System (TCS) panel is shown at right and may be found on the left-hand side of the GUI. SOAR's TCS is constantly polled for information during operation of the spectrograph, and the parameters it returns are updated on this panel. Most of this information is written to the FITS header when an exposure is taken.

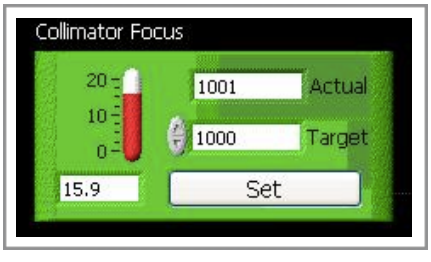
The status bar at the bottom indicates whether the subpanel is receiving data from the TCS. This indicator will display "Reading telemetry from TCS..." when successfully collecting information from the TCS and "timeout..." when the connection is faulty. Data that do not arrive to the TCS subpanel will not make its way to the FITS header files when taking images.

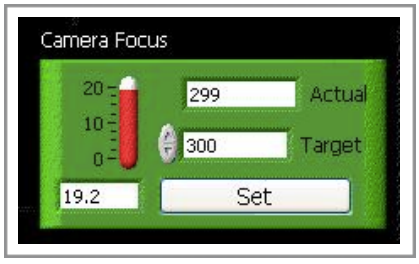
3. The Subsystems Panel

This panel, which takes up most of the space on the GUI, gives users control over all of the mechanical systems on the spectrograph. It is subdivided into nine subpanels, most of which are color-coded to match the parts of the instrument they control, as shown in the picture of the spectrograph in the center of the GUI. Status lights on the left side of the Subsystems Panel indicate one of four states for each subsystem's motors: uninitialized (dark green), ready (light green), yellow (moving), red (error). Further details concerning each subpanel follow.

(i) Collimator/Camera Focus

Both the collimator and camera optics assemblies translate to adjust the focus of the system. Control over the position of these systems is given to the user through the Collimator Focus and the Camera Focus subpanels, which are identical to one another and shown below.



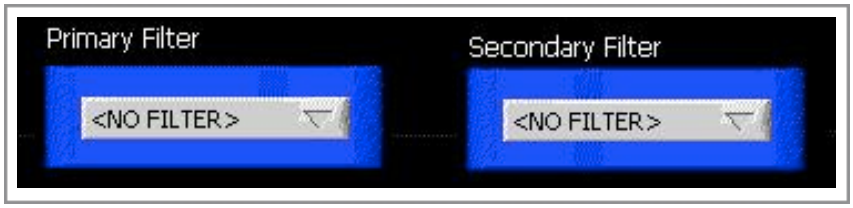


The *Actual* indicator box displays the current position of each lens system. To change the focus, the user may enter the desired position in the *Target* control box and click *Set*. If the desired position is outside the permitted range, the entered value will be coerced to the nearest acceptable value.

The gauges on the left side of each subpanel are linked to temperature sensors that may be magnetically attached to any component of the Goodman spectrograph. Due to their mobility, these gauges do not necessarily reflect the actual temperatures surrounding the collimator or camera focus environments.

(ii) Primary/Secondary Filter Wheels

The Goodman Spectrograph can hold two filter wheels at a time. Users may insert filters using the *Primary Filter* and *Secondary Filter* subpanels, located at the bottom center of the main control system.



To select a filter, click on the drop-down menu and choose a filter. If no filter is desired, the *<NO FILTER>* option should be selected. Filter positions that do not have filters are labeled *<EMPTY>*.

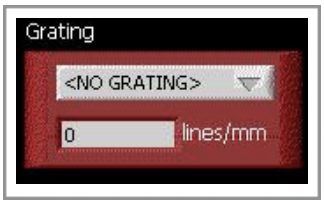
(iii) Mask (Slit) Assembly

The *Mask* Subpanel is shown below. As with the filter wheel subpanels, clicking the drop-down menu reveals the list of available slit masks. To load a slit mask, click on the desired mask, and wait for the system status light to turn green. One should note that out of all the instrument's subsystems, this particular movement requires the longest amount of time.

Any loaded slit mask may one of two positions: (1) in the image beam and (2) withdrawn from (out of) the beam. The animated picture at the bottom of the subpanel will update to remind the user of the current slit position. The position of the slit may also be inferred from the label on the button below the drop-down menu. If the slit is currently in the field, the label will say 'Withdraw Mask.' Pressing this button will withdraw the slit from the beam path, revealing a 3' x 5' imaging field. With the slit withdrawn, the button will instead say 'Replace Mask.' Clicking this button will return the slit to the beam path. If no mask is desired, select the *<NO MASK>* option from the drop-down menu.

(iv) Grating Selection

The Goodman Spectrograph may hold three gratings at any one time. To place a grating in the beam, select one from the drop-down menu in the *Grating* subpanel (left), and wait for the indicator light to turn green. The grating assembly (colored red) in the model of the Goodman Spectrograph at the center of the GSCS will move upward, indicating a grating has been selected. Select <*NO GRATING*> to hide the grating translator stage.

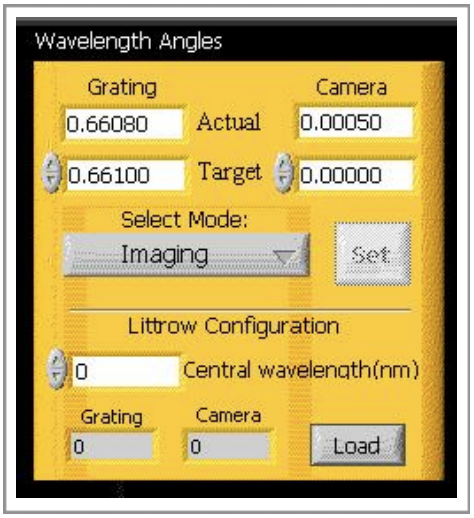


(v) Flexure Compensation

As the Nasmyth cage rotates while tracking an object, the effect gravity has on the spectrograph changes, which can change the configuration of certain subsystems, most prominently the camera and slit. This flexure changes an object's pixel location on the CCD as the rotator moves during an observation. To counteract this effect, the Goodman Spectrograph incorporates a set of Piezo motors that must be activated upon start-up of the GSCS. To turn on flexure compensation, click on the green LED labeled ***Active?*** on the flexure compensation subpanel.

(vi) Wavelength Angles (Camera/Grating Angles)

The subpanel controlling the angles of the camera and grating is shown below. Up-to-date camera and grating angles are displayed in their corresponding boxes next to the label 'Actual.' During observations, these numbers should remain stable out to the 4th or 5th decimal place if flexure compensation has been activated.



To image with the spectrograph, select "Imaging" from the *Select Mode* drop-down menu, and wait for the indicator light to turn green. Choosing camera and grating angless for a spectroscopic setup is less simple since these angles (in conjunction with the grating being used) determine the wavelength-to-pixel mapping of the resulting spectrum. In the *Select Mode* drop-down menu, one will find several standard modes which have been set up and characterized to maximize throughput. In addition to these standard modes, observers may implement user-defined modes. There are three different ways to choose and set the wavelength and grating angles for your observations; they are listed below.

i) Choose a standard mode (highly recommended)

To select a standard mode, click on the drop-down list of observing modes on the *Wavelength Angles* subpanel and choose the desired mode. The appropriate *Target* values will then be loaded, and the wavelength assembly stage will move into place.

ii) Use a wavelength-centered mode

Insert the wavelength (in nm) you would like to center in the spectrum in the *Central Wavelength* input box under *Set Littrow Configuration*, and click *Load Target Values*. The GSCS will compute the required camera and grating angles and display them in their corresponding *Target* boxes near the top of the subpanel. As this calculation depends on the grating to be used, the grating *must already be in place* at the time of this calculation. Selecting *Custom* from the drop-down menu and then clicking *Set* will move the camera and grating to the calculated positions. The *Set* button is only activated when *Custom* is selected from the pull-down menu.

iii) Use a user-defined mode

Enter the desired camera and grating angles into their corresponding input boxes next to the 'Target' label. Select *Custom* from the pull-down menu, and press *Set* to move the camera and grating. The *Set* button is only activated when *Custom* is selected from the pull-down menu.

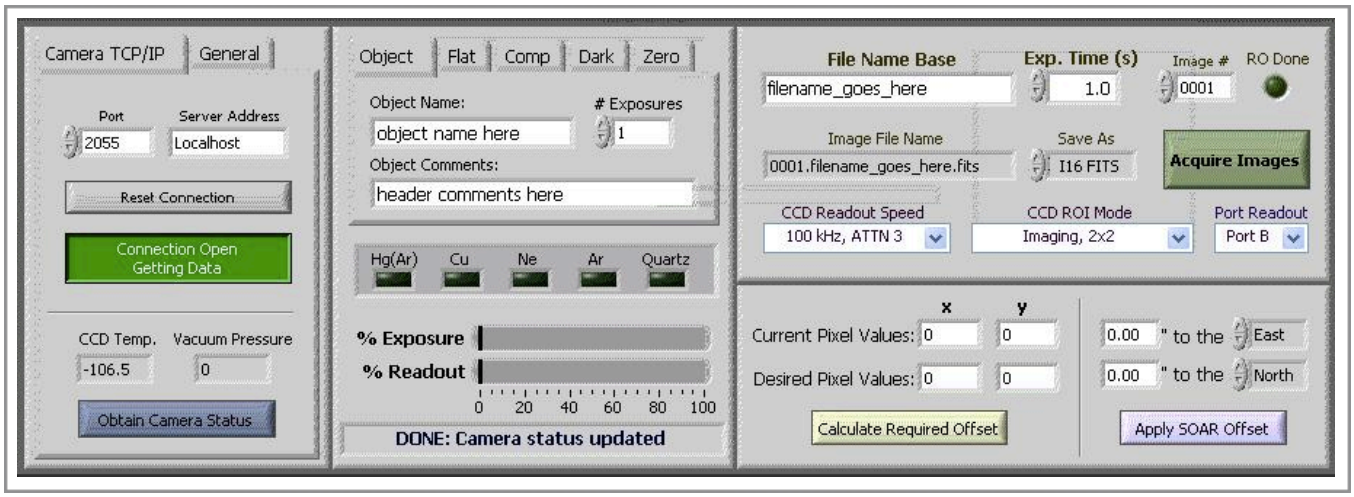
(vii) Mask Imaging Subpanel

The *Mask Imaging* subpanel is located at the top center of the subsystems panel. The purpose of this subpanel is to increase observing efficiency when going between spectral and imaging modes.

Clicking the *Image Slit* button hides the grating and moves the camera to an angle of zero (leaving the grating angle unaffected). Upon clicking this button, the *Imaging* LED light will turn red, and the text on the button will change to "Return." Clicking the "Return" button will move the grating and the camera angle back to the positions they were at *right before* the "Image Slit" button was originally pressed. Changing the grating, camera angle, or grating angle when the "Return" button is visible will reset the button to its "Image Slit" mode. Users may observe in all possible modes without ever using the feature on this panel; it is simply meant to increase observing efficiency.

3.9 Camera Control Panel

The *Camera Control* panel (below) is located at the top of the GSCS and is described in the sections that follow.



(i) Camera TCP/IP Tab (left)

All Goodman Spectrograph images are taken with the software, *SI Image SGL D*. The GSCS communicates with this software via a TCP/IP connection. The connection port number and server address can be controlled from this tab but should NOT be changed under any circumstances. A status bar in the middle of the panel indicates the status of the connection; a green light signifies that the connection is open, and a yellow light suggests there is an error communicating with the *SI Image* software.

From time to time, *SI Image SGL D* may experience an error (usually a timeout or semaphore-related error). Some errors may clog up or sever the TCP/IP connection with GSCS. If such an error occurs, the operators may need to restart the *SI Image* software. The GSCS may be left running during this process; however, once the *SI Image* software is up and running again, the user must press the *Reset TCP/IP Connection* button to re-connect to renew the connection properly.

Additionally, the temperature and pressure inside the camera dewar may be obtained from this panel by pressing the "Obtain Camera Status" button. The temperature, which is displayed in units of degrees centigrade, should always lie near -106.5 (the set-point temperature of the CCD). If the temperature deviates from this position by a significant amount, please inform the operators immediately. Likewise, the pressure inside the dewar (displayed in torr), should always read 0, and the user should inform the operators of any other pressure reading.

(ii) General Tab (left)

On this tab, the user may input the observer's name and the proposal number, both of which will appear in the FITS header of any image taken. The "Open Goodman Quick Look" button opens and closes the *Goodman Quick Look* program, a rudimentary image and spectrum viewing program.

(iii) Observation Type Tab (middle)

Before taking an exposure, users should select the observation type from this tab. Users may select from Object, Flat, Comp, Dark, and Zero (Bias). The observation type chosen will appear next to the 'OBSTYPE' keyword in the FITS header of all acquired images. Each tab also contains inputs for the observation name, comments, and number of exposures. The inputted name and comment will also appear in the FITS header.

In addition to these controls, the 'Flat' tab contains an input box for the intensity of the Quartz Lamp. This intensity should be entered as a percentage and is uploaded to the TCS only upon turning on the quartz lamp. Users should note that the intensity of the quartz lamp is non-linear; an exposure of the quartz lamp taken at 90% will *not* be twice as bright as one taken at 45%).

(iv) Comparison Lamp Control Cluster

Control of the comparison lamps is provided to the user through the cluster at the center of the camera control panel. The available lamps are each presented next to an LED control light. To turn a lamp on or off, simply click the LED light. The intensity of the quartz lamp in particular may be controlled through the input box located in the 'Flat' tab.

(v) CCD Readout Speed

The speed with which the CCD is read out may be controlled from the drop-down menu at the right-hand side of the camera control panel. As the readout speed mode determines the gain and read noise for any image, observers may want to refer to the REFERENCE GUIDE to find help choosing the mode that best suits a particular observation.

(vi) CCD Region of Interest (ROI)

The Fairchild CCD in the spectrograph contains a total of 4096x4096 pixels, but any section of this detector may be read out during an exposure. To set a particular ROI, simply click on the *CCD ROI* pull-down menu (right side of camera control panel), and make a selection. For further instructions on choosing an ROI, refer to the document "SETTING THE REGION OF INTEREST."

(vii) *Port Readout*

The Fairchild CCD contains 4 ports with which the CCD may be read out. However, the Goodman Spectrograph system currently only employs 1 of these ports (Port B). Users with the 'observer' status will not be able to change the port readout. Users having the 'engineer' status, on the other hand, will have full control over the port selection.

(viii) *Taking An Image*

To take an image, click the *Acquire Images* button (after inputting or selecting the desired filename base, exposure time, read out mode, number of exposure, etc.). Upon this action, the "% Exposure" progress bar at the bottom-center of the camera control panel will begin to update the user with the percentage of the exposure that has been completed (and the *Acquire Images* button will change to *Stop Acquisition*). Once the exposure is complete, the readout of the CCD will commence, the status of which being shown by the "% Readout" bar. As the indication of the readout time left as shown on the progress bar is only a calculation, the 'official' completion of the CCD readout (as signaled by the camera) is indicated by the "RO Done" LED light at the top right of the camera control panel. Once this indicator has been illuminated, the system is ready for the next exposure.

(ix) *Aborting An Exposure*

An exposure may be aborted by pressing the *Stop Acquisition* button, which will send an 'abort' signal to the *SI Image* software. After pressing this button results, the user is presented with two error messages that may be dealt with simply by clicking the 'Continue' button on each one. DO NOT press the 'Stop' button. Once the user has cycled through these windows, the functionality of the system typically returns to its ordinary state. Additional reference: ABORTING EXPOSURES

(x) *Offsetting the SOAR Telescope*

Users may apply small offsets to the SOAR telescope via the controls in the lower, right-hand corner of the camera control panel. There are two ways to do this:

a) Apply a calculated offset.

Using IRAF or some other data-viewing software, one should locate the coordinates of the object to be moved and its desired location. Enter the current coordinates of the object in the *Current Pixel Values* control boxes and the desired coordinates in the *Desired Pixel Values* boxes. Clicking *Calculate Required Offset* will take these coordinates, calculate the needed offset, and display the offset values and directions in the appropriate boxes at the right. Subsequently pressing the *Apply SOAR Offset* button will offset the telescope using these parameters.

NOTE: The ROI mode of the images used to find the coordinates must match the ROI mode set at the time when the calculation is performed; otherwise, the offset will be invalid.

b) Apply an estimated offset

On the right half of this panel, an observer may set up an offset by entering the length of the offset (in arcseconds) and choosing the corresponding directions of the offset (North/South, East/West). Pressing the *Apply SOAR Offset* button commands the telescope to move as governed by the specified offsets.