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Goodman HTS Manual

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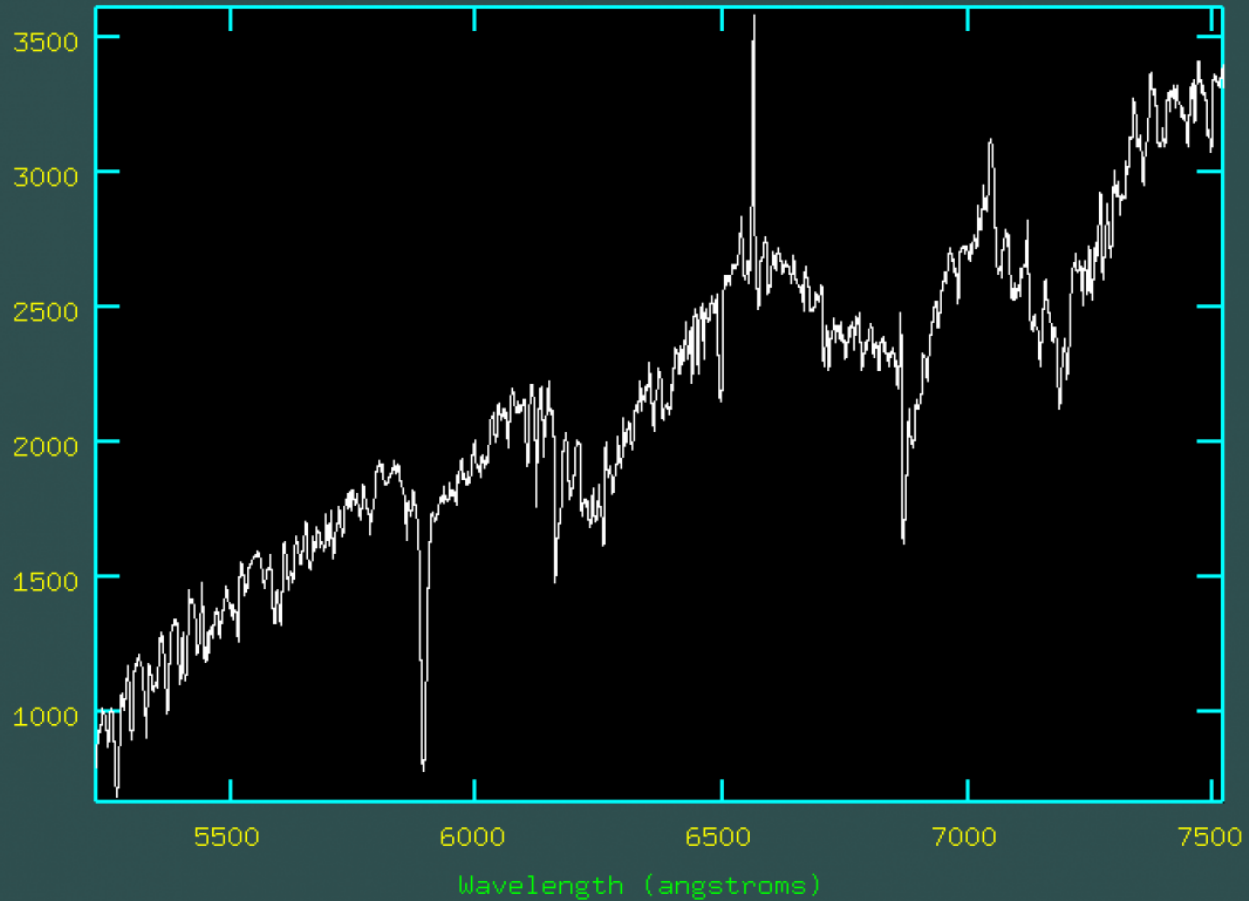
Goodman High Throughput Spectrograph

User Manual

Updated Mar 2017

C. Briceño/S. Points

NOAO/IRAF V2.16.1 briceno@Cesars-MacBook-Pro.local Wed 19:02:21 06-Aug-2014
[ori2_comb_1d.2_wl.fits[1][*,1,1]]: orion field-2 900. ap:2 beam:2



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Introduction to the Goodman HTS

Instrument Overview

The Goodman High Throughput Spectrograph has been upgraded to provide users with the *choice of one of two separate cameras*.

One is the original UV-optimized **Blue Camera**, with a 4096x4096 Fairchild CCD. The new device is the **Red Camera**, equipped with an e2v 4096x4096 detector optimized for work at red wavelengths with negligible fringing redward of ~650nm compared to the Blue Camera. For both detectors the pixel scale is the same (0.15 arcsec per pixel). This provides a 3096 x 3096 unbinned pixels (~7.2 arcmin diameter) FOV in imaging mode and a 4096 x 1896 unbinned pixels FOV in spectroscopic mode. The long slit masks in spectroscopic mode are approximately 3.9 arcmin in length and cover ~1560 unbinned pixels, leaving enough pixels above and below the slit to obtain an estimate of the stray and scattered light.

In both cameras, the CCD is read by the [Spectral Instruments](#) [34] controller. In the Blue Camera through 1 amplifier.

Blue Camera: Depending on binning and the gain setting, the CCD can be read in as little as 20 seconds (1x1 fast readout) to as long as 80 seconds (1x1 slow readout) in spectroscopic mode. Please see the table given in the [Goodman Overview](#) [2] page for a more detailed description.

The data are taken via a vncviewer on the Goodman data acquisition computer (soaric6 for the Red Camera and soaric2 for the Blue Camera) and examined via a vncviewer on the Goodman data analysis computer (soaric7). From soaric7, one can transfer the data to their home institution using "scp".

Unbinned Goodman spectra plus overscan and header information are approximately 16 Mbytes each. A typical night produces about 2-4 Gbytes of data and easily transferred over the internet. This is the preferred method of the SOAR partners. If this is unfeasible, please contact Sean Points prior to your run so that other options can be discussed.

The Goodman imaging (first) filter wheel contains space for 4 square 4x4 inch filters, plus one blank

position. The second filter wheel holds 4 inch diameter circular filters, and has 6 positions, 5 regularly equipped with the order sorting spectroscopic filters, and one open position. Filters may be up to 10mm thick.

For the list of available filters look at the [SOAR Filters page](#). [35] Special arrangements for installing filters should be consulted well in advance of an observing run with the Instrument Scientist.

Philosophy and Structure of this Manual

This manual is intended for an observer planning to use the Goodman spectrograph. It is not intended to serve as a hardware or software reference document describing the inner workings of Goodman, although some details at that level may appear to help the observer plan observing strategies. Also, we assume that the observer is already familiar with CCD cameras, spectroscopic observations, and data reductions.

The [Goodman Overview](#) [2] is at the front of this manual. If you've read this far, and don't plan to read any further, be sure you understand the [Goodman Overview](#) [2] pages.

Development of the Goodman High Throughput Spectrograph is a continuing process. Throughout the lifetime of the instrument, filters will be added, old ones replaced, and software enhanced. This manual represents the status as of the date on the cover page. We expect to revise the manual occasionally to include information gained during engineering runs, as well as to reflect new filters.

Supplemental Information

[A Beginner's Guide to Using IRAF](#) [36] (*IRAF* Version 2.10), Jeannette Barnes, August 1993

[A User's Guide to CCD Reductions with IRAF](#) [37], Philip Massey, February 1997

[A User's Guide to Reducing Slit Spectra with IRAF](#) [38], Phil Massey, Frank Valdes, Jeannette Barnes, April 1992

[Guide to the Slit Spectra Reduction Task DOSLIT](#) [39], Francisco Valdes, February 1993

Goodman Spectrograph Overview

Goodman Overview

Rev. Apr 2017

At least read this!

Optics:

The Goodman optics are designed to transmit down to the atmospheric cutoff at 320 nm, and include lenses made of CaF₂ and of NaCl. The latter are the center elements of fluid-coupled triplets. None of the multiplets are over 4" in diameter which reduced the difficulty compared to spectrographs with larger pupil sizes. Each of the multiplets is sealed on one end with a face-mounted o-ring that imposes a known axial load, and on the other end with a rim-mounted o-ring that imposes a radial load, and finally held

captive axially with a retaining ring that incorporates a third o-ring. This last o-ring does not participate in the sealing of fluid, but avoids a metal glass interface that would be undesirable for the CaF₂ lenses. The salt lenses are held by the other optics and are never in contact with a seal.

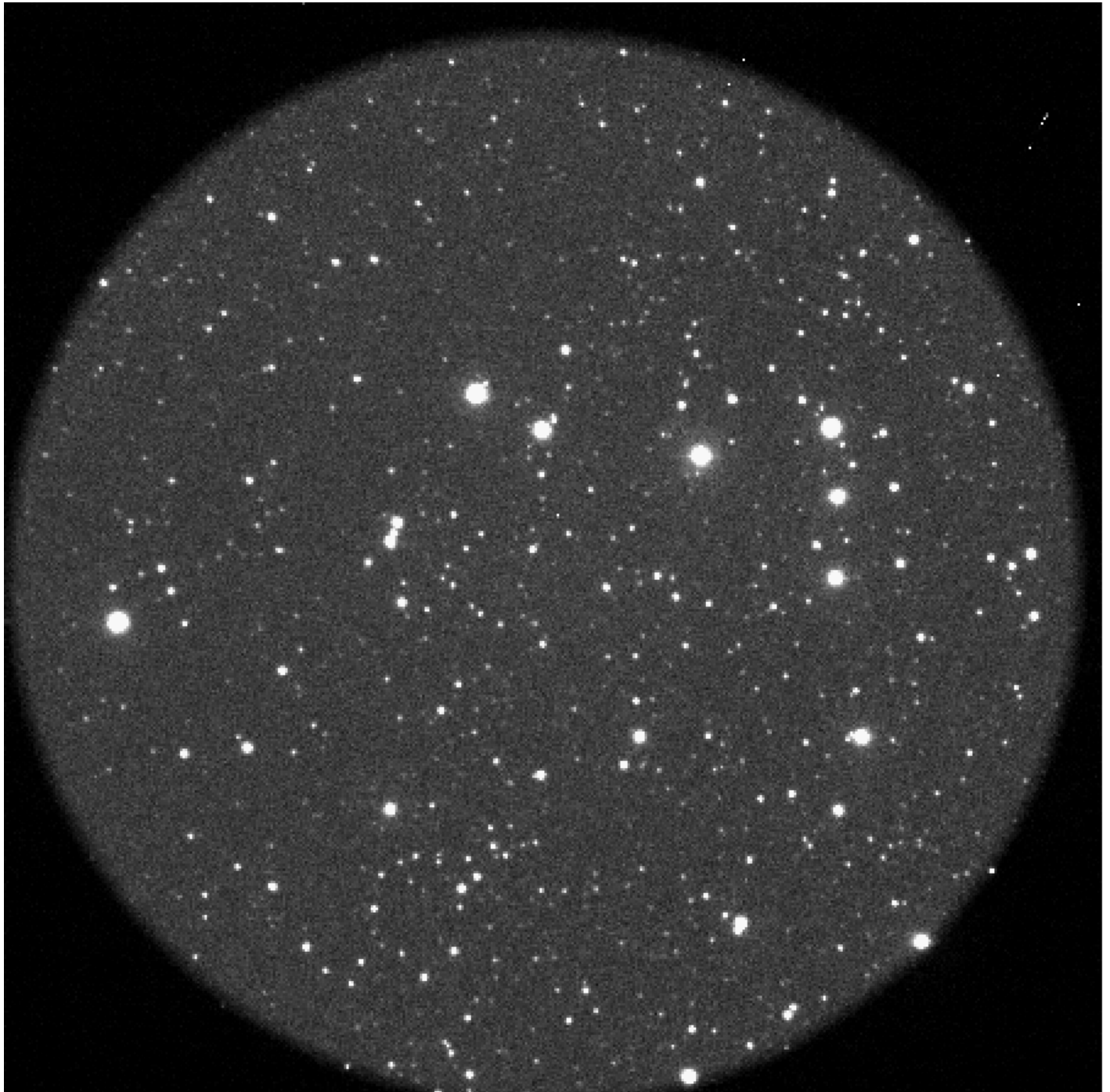
Filters:

There are two independent filter wheels: One holds 4 x 4 inch square filters, and can be fit with 4 filters. The second wheel holds 4 inch diameter filters, and normally holds the 5 order-sorting filters.

- The imaging filters include SDSS u, g, r, i and z, and Bessell U, B, V, R I sets. **Only 4 filters of the 4x4 inch imaging filters can be installed at a time.**
- The spectroscopic order sorting filters includes GG-385, GG-455, GG-495, and OG-570 filters. These are always mounted (However, we expect observers to request them specifically in their Instrument Setup forms.)

The full list of available filters can be accessed in the [SOAR filter list page](#). ^[35]

The filters are in the collimated beam (tilted to avoid ghosts). Installing different filters is straight forward, but is a day-time operation. Special arrangements for filter installations should be consulted with the Instrument Scientist well in advance of the observing run.



Imaging Mode

In imaging mode the **plate scale is 0.15 arcsec/pixel and the field of view is 7.2 arcmin in diameter (3096 x 3096 unbinned pixels)**. Filters available include Bessell UBVRI, SDSS ugriz, and VR. See the [SOAR filter list](#)^[35] for other filters

Spectroscopic Mode

In Spectroscopic mode the Goodman Spectrograph can obtain both single, longslit spectra *and* spectra of multiple objects simultaneously over a field of 3.0 x 5.0 arcminutes using multi-slit masks. A carousel style mask changer, holding up to 36 masks allows the slit plates to be interchanged and located at the instrument entrance aperture.

Single Slit masks:

[The instrument is currently available with the following compliment of fixed long slits:](#) ^[40] **0.45, 0.60, 0.80, 0.95, 1.0, 1.2, 1.5, 1.9, 3.2, 4.0, and 10.2 arcsec wide.** ^[40] **Each slit is 3.9 arcminutes long.**

Note: [the Goodman Acquisition Camera \(GACAM\)](#) ^[41] has a FOV=1.8 arcmin in its longest dimension, therefore, it does not span the full length of a Goodman long slit. If your science requires a full view of the long slit you will need to use the pre-imaging procedure for object acquisition ([see the Step-by-step guide to Observing with Goodman](#) ^[42]).

Multi-Slit Object (MOS) masks:

Each Goodman MOS mask spans a field of view of 3x5 arcmin on the sky.

Within this field the user can arrange multiple slits of various width and lengths. The process of creating mask files for approved programs is the responsibility of each program PI. A [Slit Designer software](#) ^[43] that runs on Windows 7 (a port for Mac OSX in in the works) has been developed by the Goodman Lab group at UNC. Masks are required to be sent to the following e-mail address:

goodman_mos@ctio.noao.edu ^[44] at least **1 month before the observations** are scheduled. In your mask submission you need to attach the following files: FITS image of each field -with WCS-, and the .g, .msk, .txt files generated by the Slit Designer software. Currently, the PI also can access remotely a SOAR Windows 7 machine with a working [Slit Designer software](#) ^[43]. For details, contact SOAR Goodman Support Scientists.

Gratings and Preset Observing Modes:

Up to three (3) gratings can be installed in the spectrograph at a time, in a linear stage which allows the rapid interchange of gratings. Installing different gratings is a day time operation. **No grating changes are done during the night.**

Goodman has now different Blue and Red-optimized options for the 1200 l/mm grating.

Please check the updated list of currently available gratings in the [Goodman Spectrograph Gratings page.](#) ^[45]

The table below shows the dispersion and the wavelength coverage for observations in our set spectroscopic modes. Please note that the 1800, 2100, and 2400 l/mm gratings are operated in Custom mode where the observer selects the central wavelength for their observations. Because of limits in the camera rotation stage, it is not possible to use the 2100 and 2400 l/mm gratings beyond certain wavelength limits.

Grating (lines/mm)	Dispersion (Å/pixel)	Coverage (Å)	Max R @ 550nm (3pix with 0.46" slit)	Blocking Filter
400	1.00	M1: 300-705 M2: 500-905	1850	— GG-455
600	0.65	UV: 301-569 Blue: 350-616 Mid: 435-702 Red: 630-893	2800	-- — GG-385 GG-495
930	0.42	M1: 300-470 M2: 385-555 M3: 470-640 M4: 555-725 M5: 640-810 M6: 725-895	4450	— — GG-385 GG-495 GG-495 OG-570
1200	0.31	M0: 302-436 M1: 350-485 M2: 420-550 M3: 490-615 M4: 555-685 M5: 625-750 M6: 695-815 M7: 765-880	5880	— — — — GG-455 GG-455 GG-495 OG-570
1800	0.19	800	9610	As needed
2100	0.15	630	11930	As needed
2400	0.12	510	14280	As needed

The VPH gratings operate via Bragg scattering and their efficient operation requires Littrow or near-Littrow operation of the spectrograph. A grating rotation stage sets the incident angle to the desired value, which depends upon the line density of the grating and the central wavelength of interest. A concentric camera rotation stage must then be set to nearly twice this angle to intercept the diffracted beam. A set of fixed observing modes for each grating are given below, where applicable. ***All gratings can be used in the Custom mode.***

Calibration Lamps:

We have a quartz lamp for spectral flats and HgAr, Ne, Ar, and CuHeAr lamps for wavelength calibration. Plots of these spectra with the lines identified in each of our standard spectroscopic modes can be found in the [Goodman Comparison lamp web page](#). [46]

With the 400, 600 and 930 line gratings we recommend also taking Dome Flats during your afternoon calibrations.

Choice of Detectors

If science program requires:



BLUE CAMERA

[9]

- Best throughput down to UV atmospheric cutoff
- It is an ongoing programs using Blue Camera
- Maximum flexibility to create small ROIs on-chip, e.g., for fast time-series photometry



RED CAMERA

[10]

Most programs requiring wavelengths redward of ~ 4500 Å will benefit from the enhanced red throughput and minimum fringing provided by the red camera.

Fringing Measured in the Goodman Blue and Red Cameras. Peak to peak.

Wavelength (Å)	Blue Camera Fringing (%)	Red Camera Fringing (%)
7800	3	0
8500	10	0.3
9000	22	<1

Use of blocking filters:

Those taking spectra to the red of $\sim 600\text{nm}$ should be aware that, depending on the spectrum of their target, there may be significant contamination from second order blue light superposed on the first order

red spectrum (a blue leak). The blue leak will change the apparent shape of the red continuum, "fill in" absorption features in the red, and may "imprint" emission or absorption features occurring in the blue spectrum at roughly twice their wavelength. This second order contamination can be eliminated by use of an appropriate blocking filter. However, this does entail a loss of efficiency in the red since the "in-band" transmission of the available blocking filters is not 100%.

Those needing spectrophotometric calibration should note that essentially all spectrophotometric standards are quite blue, so there will be a significant blue leak if they are measured without a blocking filter, which will invalidate the calibration of science target spectra, even if the targets themselves have no blue flux. A possible approach would be to measure the science targets without a blocking filter, the standards with one, and then correct the standards for the blocking filter transmission. However, we currently do not have measurements of the blocking filter transmission which we consider sufficiently reliable for these purposes. In the meantime observers who plan to do this should measure their own by observing a red star with and without blocking filter.

In principle contamination by the blue leak will also effect arc lamp calibrations (superposing blue lines on the red spectrum at roughly twice their wavelength) and flat fields. However, with the exception of the HgAr lamp the blue lines in all the calibration sources are very weak compared to the red lines, and similarly the flat field sources are much brighter in the red than the blue.

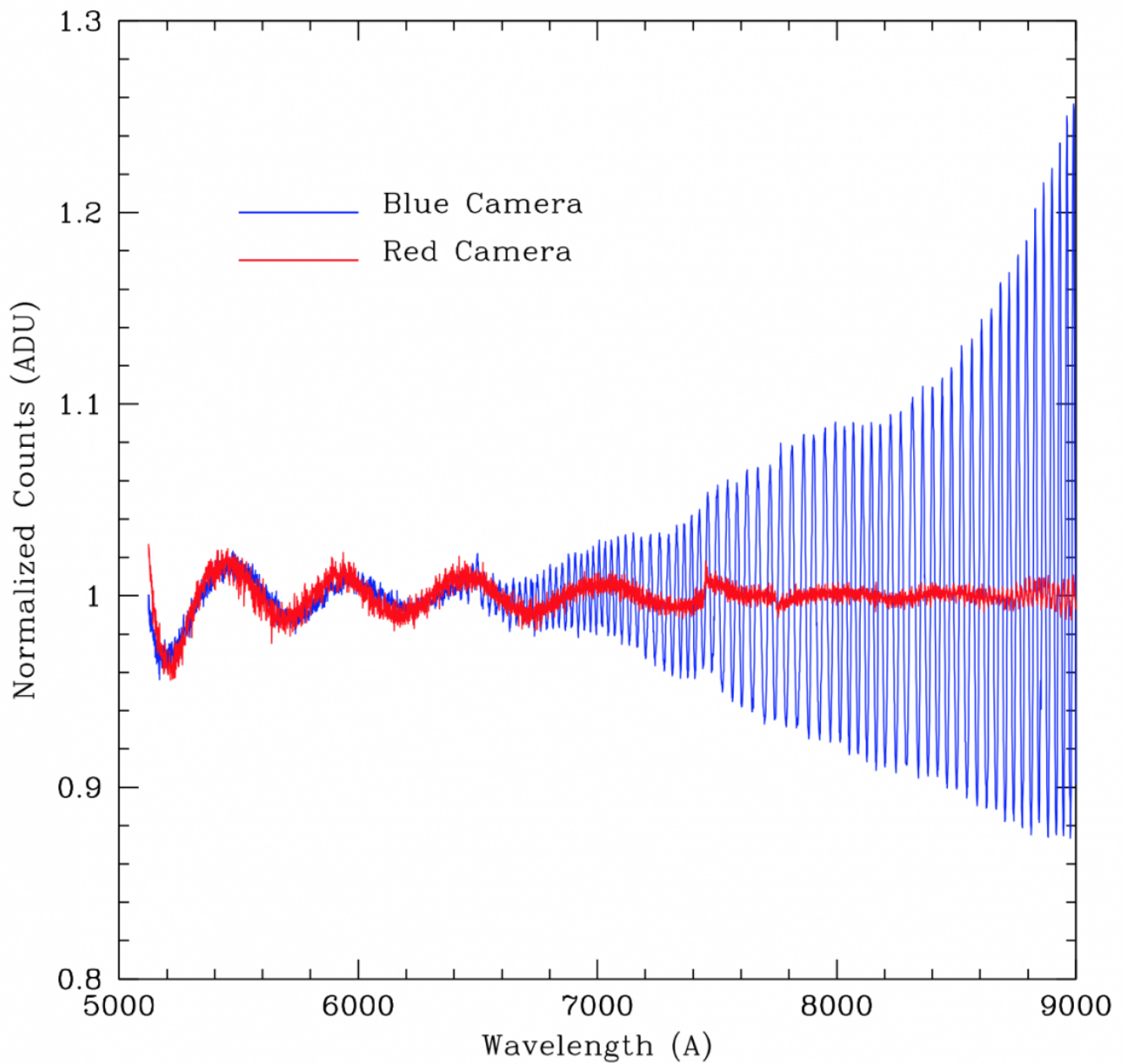
Scattered (and Stray) Light:

Measured to be small in imaging mode by comparing imaging FOV and surroundings with a bright star illuminating the pupil. Some scattered and stray light is seen in the Goodman spectroscopic mode. We currently see 0.06e/s of stray and/or scattered light in the spectroscopic mode with 1x1 pixel binning and the 100kHz ATTN2 readout. Efforts are underway to replace the tent that covers Goodman with a light-tight box. We are also looking for low-level emitting LEDs on all of the Goodman motors and covering them with metallic tape as we find them.

Calibration Issues:

Obtaining good quartz spectra over the entire wavelength range with the 400 l/mm grating is difficult because of the different spectral response at the red and blue ends. The most noticeable effect is that to obtain sufficient counts in the blue end, the red end becomes saturated. A blocking filter is on order so that composite quartz flats can be made. This effect is not as great with the other gratings because the wavelength range isn't as large.

There also exists contamination of the flats by scattering from the back of the second filter wheel. Use of the blocking filter mentioned above mitigates this contamination. Finally, with the BLUE CAMERA fringing appears in the spectra to the red of the H α line. With the availability of the RED CAMERA, fringing at red wavelengths is greatly reduced, as can be seen in this plot below.



Flexure:

The instrument has active flexure compensation based on the Nasmyth rotator angle. The corrections are successful at the fraction of a pixel level for the full range of rotator angles.

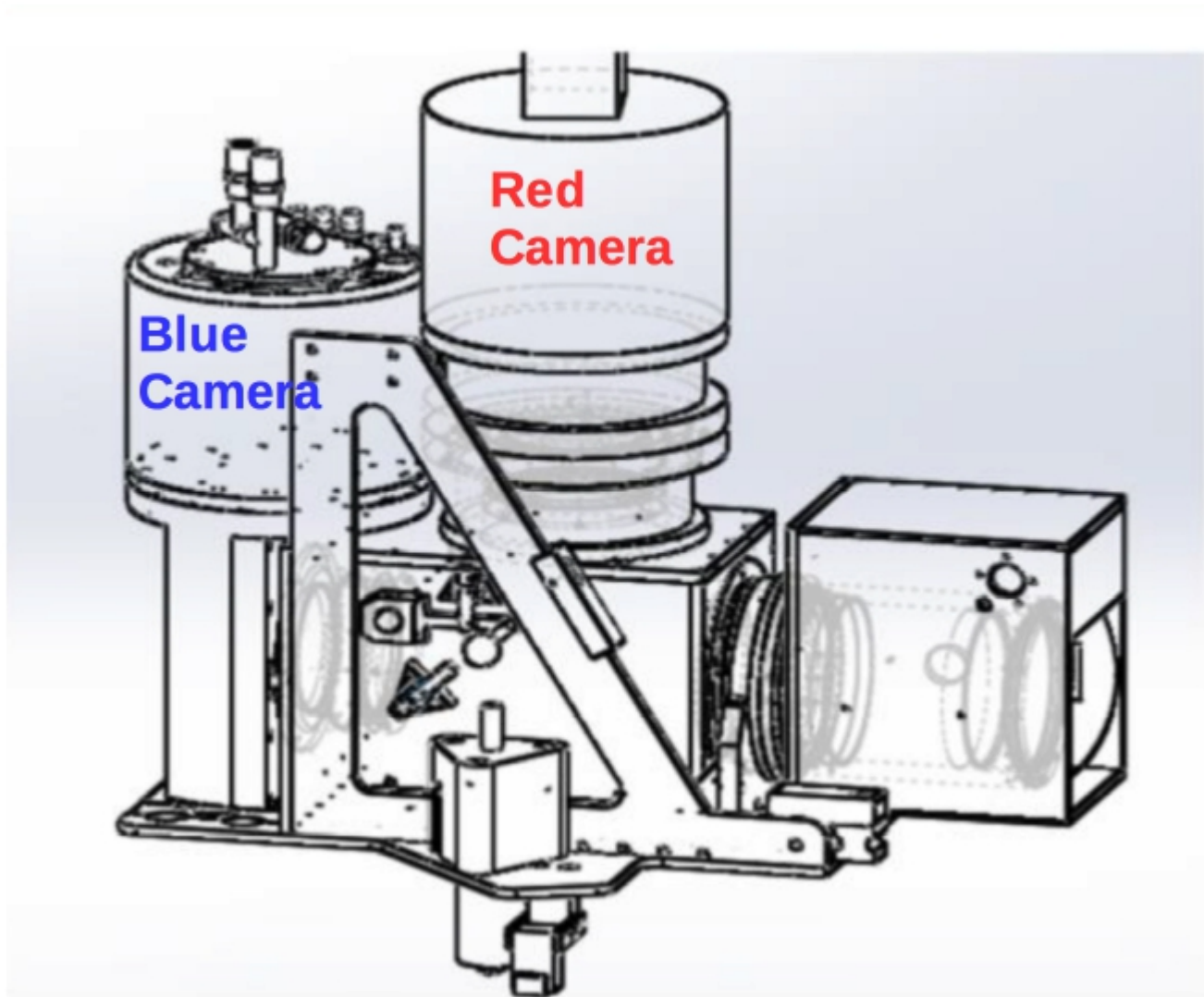
The Goodman Hardware

In this section you will find a description of the hardware and main components of the Goodman HTS.

[Click on this link for a PDF file containing photos and further notes of each mechanism.](#) [47]

The Blue/Red Camera Stage

Both the [Blue](#) [9] and [Red](#) [10] cameras are installed on an articulated stage, which is moved by a wormdriven annular stage directly encoded with a resolution of $0.6 \mu\text{-radians}$. To minimize flexure the camera platform rides on a concentric 400mm curved bearing rail. The platform that holds the camera optics and dewar is attached at two points to the central stage and at two points to the bearings on the curved rail. The coupling between the bearing assembly and the camera platform is through tuned flexures that both relieve the overconstraint between the central bearing and the rail, and act as a restoring spring for two piezo-electric actuators that can move the whole platform up and down to compensate for instrument flexures. These flexures are pre-loaded with 100kg of tension, which is more than twice the total weight of the camera assemblies, to insure that the bearings on the curved rail remain on the same contact surface (the underside of the rail) during rotation of the instrument. Flexure compensation on the orthogonal axis uses the articulation motion at very low speed.



The Camera Focus Stage

The camera optics tube rides on lead-screwdriven crossed roller bearing stages. The camera stage is a custom low profile design that had to be incorporated into the articulation assembly. The camera focus stage incorporates external temperature sensors, constructed from temperature-to-voltage converters that feed built-in analog-to-digital converters in the Silvermax motors driving the stage. The optics mounts do not include passive thermal compensation, so measurements are required to correct for focus changes with temperature.

The Shutter

The clear aperture at the front of the camera is 4" and it is 2.8" at the last optic, which doubles as a dewar window. The shutter adds only ¼" to the width of the camera optics (except for a strategically positioned motor), and adds only 1" in length to the front of the camera. It consists of a friction driven curved stainless plate 0.010" thick that rides in a curved teflon track to cover the 4" entrance to the camera optics. The stepper motor can open or close the shutter in under 200 msec.

The VPH Gratings

We have available VPH gratings of 400, 600, 930, 1200, 1800, 2100 and 2400 l/mm, that have been produced in a holographic exposure facility at UNC that is currently capable of making 4" size VPH gratings. These gratings are of quality equal to or exceeding those produced by most vendors.

The Grating Rotation and Translation Stages

The grating changer can position any of three gratings at the 75 mm pupil, or lower them out of the way for imaging mode. This translation is subordinate to the grating rotation, so that the grating can be inserted and removed quickly from the pupil without resetting the angle. The rotation is driven by a Newport rotary stage at the bottom and a matching bearing at the top. This stage was retrofitted with a Silvermax motor. The stage is directly encoded with a resolution of 0.9 μ -radians, and the Silvermax motor uses feedback from this encoder for fine position control. Gratings are mounted in frames that are held by ball detents in the translation mechanism.

The Filter Wheels

The Goodman spectrograph uses two filters wheels.

The first filter wheel is used mostly for imaging. It can hold up to 4 holds 4x4 inch square filters. The [SOAR filter page](#) [35] shows the list of available filters.

The second filter wheel has 6 positions for 4-inch diameter circular filters. It normally holds the 5 spectroscopic order sorting filters, and an open position.

Filters are placed in the collimated beam where they cause a pupil shift instead of a more irritating refocus, but this made them large, to accommodate the 75 mm pupil, and difficult to place. The wheels are suspended from a plate mounted to a cantilevered extension to the truss. The wheels are tilted enough to place any reflection ghosts the filters generate outside of the imaging field. Filters are mounted in rings that are held in the wheels using spring loaded ball detents. This allows exchange of filters without tools or fasteners that get lost or dropped in the instrument. Likewise, the wheels are held on their bearings by a hub that can be removed by hand. The wheels have teeth around their perimeter

and are driven by smaller gears engaged by a spring loaded mechanism.

The Collimator

The Goodman Spectrograph collimator has a set position at this time and cannot be moved. The collimator focus value is 1000.

Slit Masks

Goodman slit masks are 3x5 arcmin on the sky. Single longslits are available in widths ranging from 0.46 to 10 arcsec. They are all roughly 3.9 arcmin long. See the [Goodman longslit page for more details](#). [40]
Slit masks are installed on a 36 position carousel.

Multiobject slit masks are also 3x5 arcmin on the sky. At present the mask carousel can hold 17 MOS masks at one time, the remaining 19 positions are used by longslits, image slicers, and a few non-operative slots. Changing MOS masks is a daytime operation.

The Goodman Software

The Goodman Spectrograph Control System (GSCS) is a system of Labview programs running on a Windows machine, with which observers control the spectrograph and take data using its CCD camera. To access this software, users must use a graphical desktop sharing system to connect to the spectrograph's control computer. We recommend using a VNC connection (see the [SOAR Remote Observer's Guide](#) [48]), but other types of software may be used, such as Windows Remote Desktop. The following set of instructions for linking to the Goodman computer assumes that the user has established a secure VPN connection and will use a VNC or Remote Desktop session ([click here to for a PDF document providing additional information on how to connect and run the Goodman GUI](#)). [49]
This document shows the example for the Blue Camera. For the Red Camera only the name of the computer changes (see below).

Logging on to the Data Acquisition and Data Analysis Computers

The data acquisition computers are:

- **soaric2** if using the Goodman [Blue Camera](#) [9]
- **soaric6** if using the Goodman [Red Camera](#). [10]

The data visualization computer running IRAF is **soaric7**. A number of different ways to logon to these machine exist, depending upon your preference. These methods are discussed below.

- **From Cerro Pachón:**
 - The mountain staff or your support scientist will show you the computer on which you can

obtain and analyze your data. To open the Goodman user control panels:

- Double click on the "Scroll Lock" Key
- A window will open displaying the names of the computers to which you can connect
- Use the "Up" and "Down" arrow keys to highlight a free machine.
- If the Data Acquisition and Analysis windows are running, you can skip to the GUI Layout section of this manual. If these GUIs are not running, skip to the Starting and Stopping the Data Acquisition GUI and Starting and Stopping the Data Analysis GUI sections of this Manual.

- **From the Remote Observing Center in La Serena:**

- Log on to the observing account using the username and password provided to you by the instrument scientist (Sean Points, César Briceño, Regis Cartier or Alfredo Zenteno if your time is through NOIRLab or Chile, or your Brazilian Support astronomer if you are observing through Brazil time). If forgotten, these are posted on a list near the door.
- Start the Data Acquisition GUI by typing the following command from a terminal command line on the GNU/Linux computer in the remote observing center:
 - `> vncviewer -Shared soaric2.ctio.noao.edu & (Blue Camera [9])`
 - `> vncviewer -Shared soaric6.ctio.noao.edu & (Red Camera [10])`Log on to the vncviewer with the password provided by the instrument scientist.
- Start the Data Analysis GUI by typing the following command from a terminal command line on the GNU/Linux computer in the remote observing center:
 - `> vncviewer -Shared soaric7.ctio.noao.edu:4 &`Log on to the vncviewer with the password provided by the instrument scientist.

- **If you are a Remote Observer:**

- Start the VPN connection on your computer, using the username and password information provided by your Support Scientist: Sean Points or César Briceño if your time is through NOIRLab or Chile, your Brazilian Support astronomer if you are observing through Brazil time, or your SOAR Support person at UNC or MSU.
- Start the Data Acquisition GUI by typing the following command from a terminal command line on the GNU/Linux computer in the remote observing center:
 - `> vncviewer -Shared soaric2.ctio.noao.edu & (Blue Camera [9])`
 - `> vncviewer -Shared soaric6.ctio.noao.edu & (Red Camera [10])`Log on to the vncviewer with the password provided by the instrument scientist. Set this GUI in one of your monitors.
-
- Start the Data Analysis GUI by typing the following command from a terminal command line on the GNU/Linux computer in the remote observing center:
 - `> vncviewer -Shared soaric7.ctio.noao.edu:4 &`Log on to the vncviewer with the password provided by the instrument scientist. Set this GUI in another of your monitors. Remember that a minimum of 2 monitors is required to carry out remote observing at SOAR, and the recommended setup is 3 monitors ([see the SOAR Remote Observer's Guide](#)). ^[48]

In most cases the GUIs should be started and you will be presented with a data acquisition screen and

data analysis screen as shown in Figure 4.

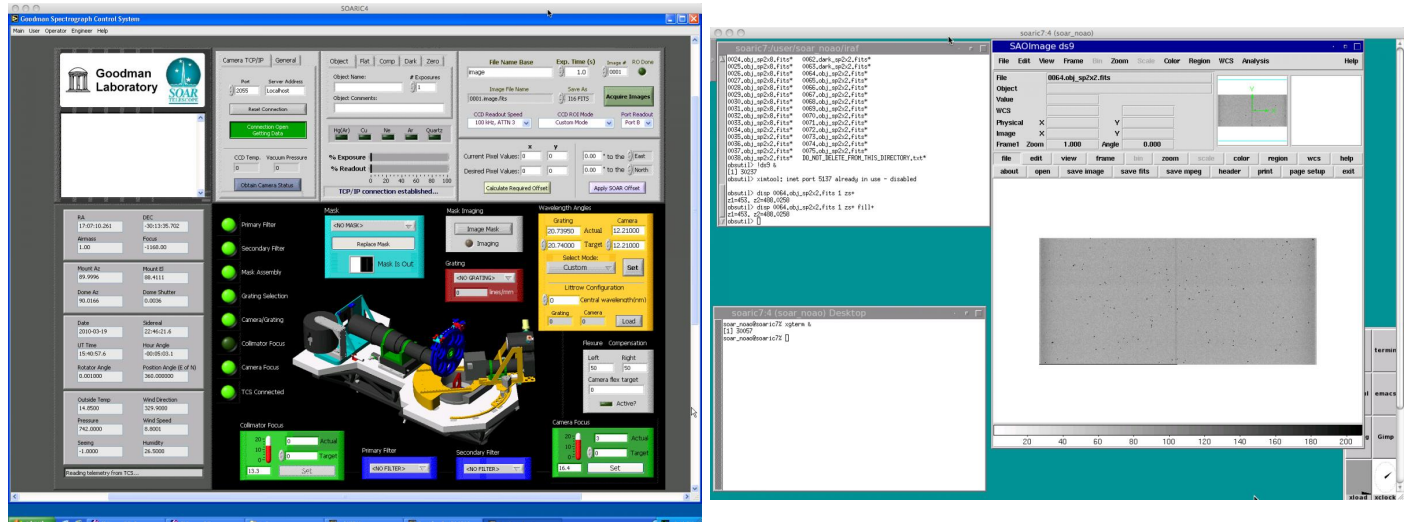


Figure 4: The Goodman Data Acquisition and Data Analysis GUI windows.

Starting and Stopping the Data Acquisition GUI

If the data acquisition GUI has not been started, then one should see a blue screen in the **soaric2** VNC window. At the bottom of the screen, you should see that the **SI Image SGL D** and **SI Image** are minimized. You may also see that the LabVIEW **Transfer_To_SOARIC7** vi and the LabVIEW **Goodman Spectrograph Control System** vi are minimized. If these are minimized, then you just need to click on them to start the data acquisition GUI. [Click here for a PDF file with additional information on the start-up of Goodman.](#) [50]

To start the data acquisition software:

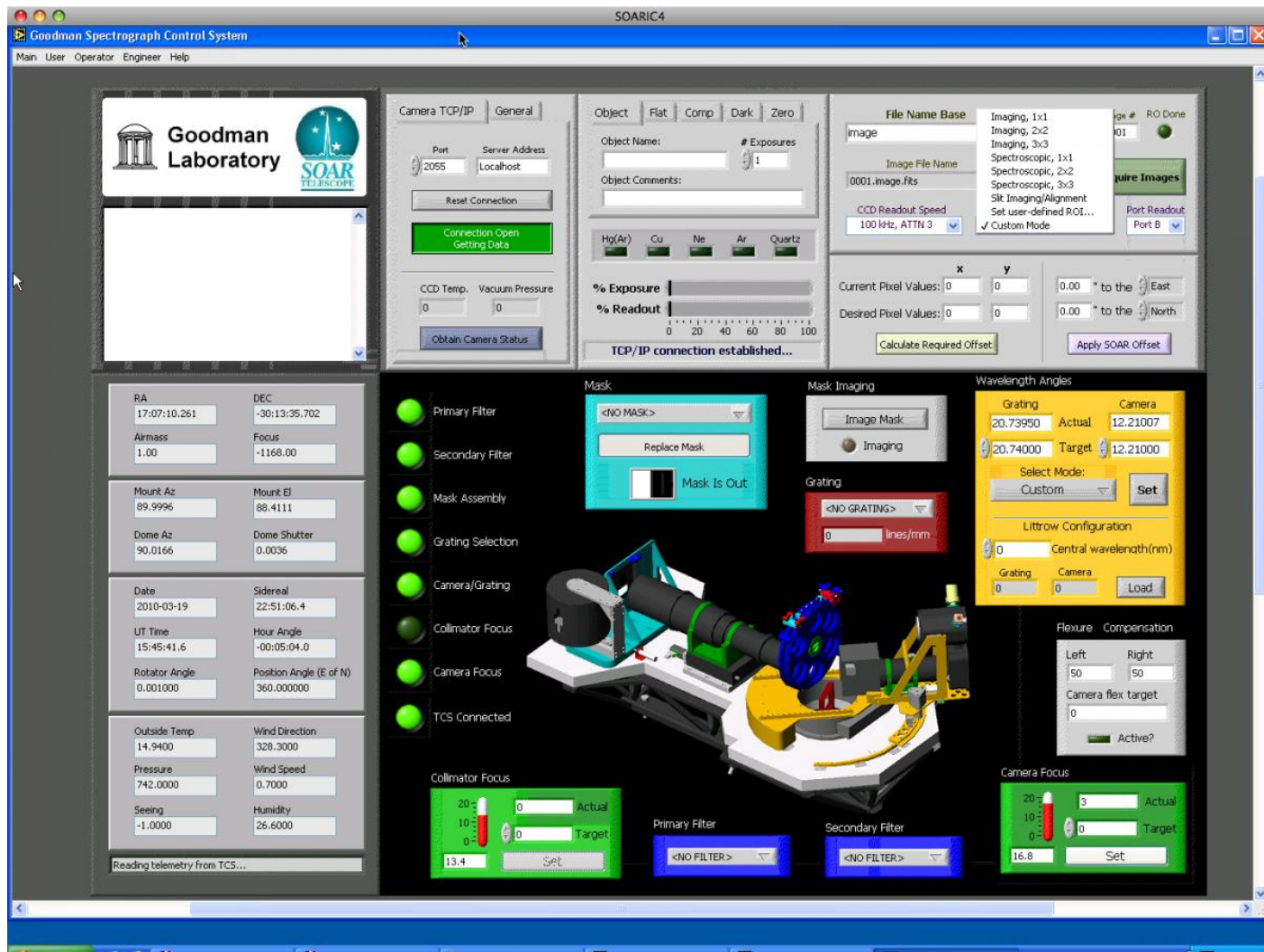


Figure 5: Selecting the CCD parameters (e.g., 1x1 imaging, 2x2 imaging, 1x1 spectroscopic, 2x2 spectroscopic, etc.)

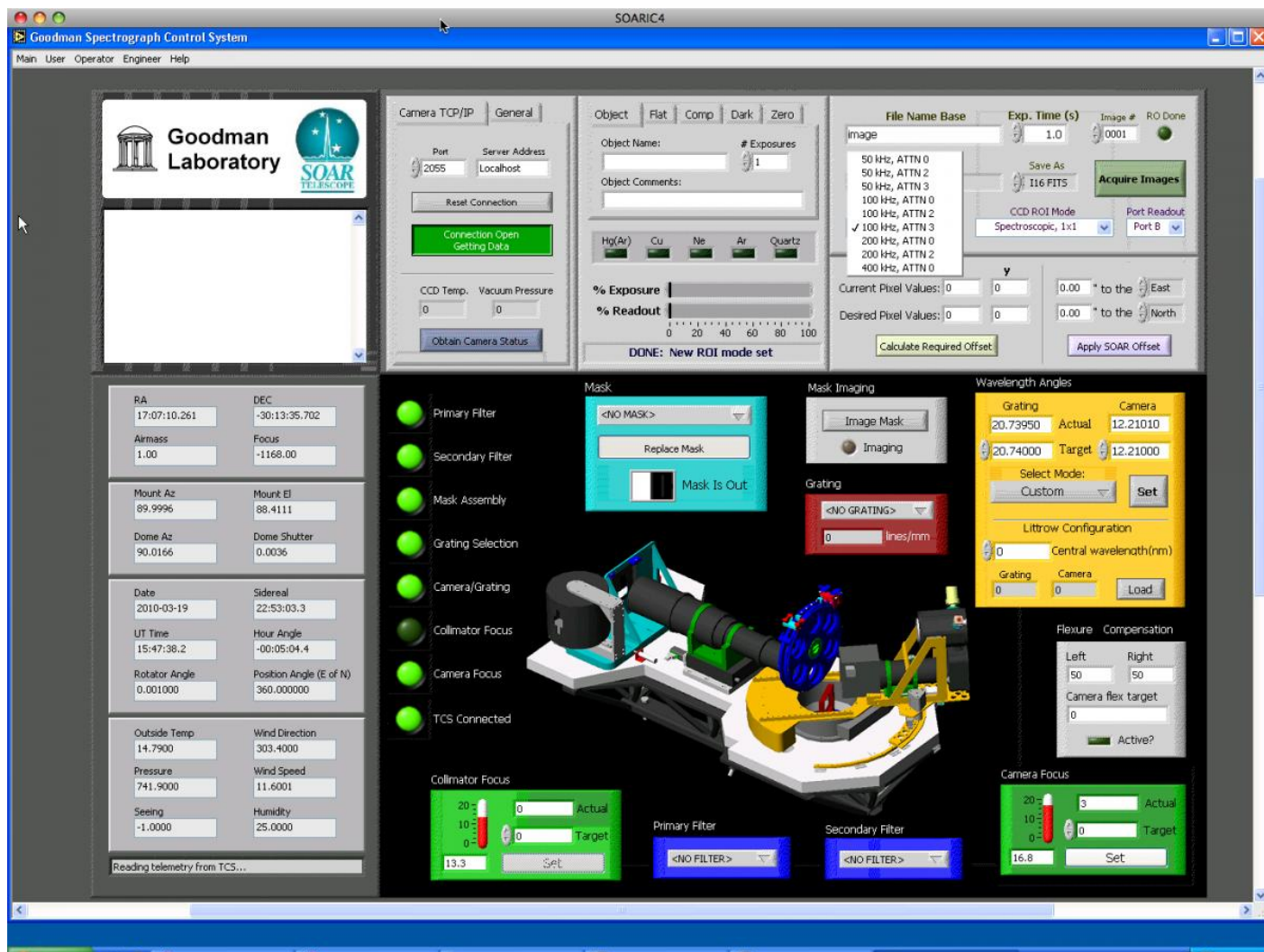


Figure 6: Selecting the detector readout parameters.

- Click the **Transfer_To_SOARIC7** LabVIEW shortcut on the Desktop and start the application by clicking on the white arrow.
- Open the Goodman controls by clicking on the **GSP_Main** LabVIEW shortcut on the Desktop and start the application by clicking on the white arrow.
- Check the camera panel. If a green button is present for "Connection Open/Getting Data" in the upper left of the GUI, Goodman "sees" the SI Image camera control software and a TCP/IP connection is available to take data. You can confirm this by clicking on the "Obtain Camera Status" button. During a normal startup of the **GSP_Main** vi the CCD Temp will read "0". If the TCP/IP connection is operating, clicking on the "Obtain Camera Status" button will show the latest temperature measurement. If Goodman is cooled, the CCD Temp should be -106.5. If the CCD Temp does not update, you will need to check the **SI Image SGL D** window and make sure that a TCP/IP connection is open.
- Click on Main tab and logon;
Use the account appropriate for your observing program (i.e., BRAZIL, CHILE, MSU, NOAO, OTHER, or UNC) with the password provided by your institution.
- Click the User tab, go to "Home Systems", and select "Home All". You should see the dark green lights change to yellow on the control panel as systems are being homed. Upon a successful

homing of the systems, all lights should be bright green, except the Collimator Focus which will remain a dark green. If there are any red lights, you will need to log out of **GSP_Main** and shutdown and cycle the power on the Goodman motor electronics.

- After the camera is homed, start the flexure correction by clicking the flexure LED. It should change from dark green to bright green.
- Select the imaging or spectroscopic mode in which you want to work.
- Select Gain and Readout Setting. These values are given in the [Goodman Overview](#) [2] and in the [Goodman Cheat Sheet](#) [3]. Usual values are 100 KHz ATTN0 with the Blue Camera, which provides gain=1.06 and readout noise= 3.72 e-, and 344KHz ATTN3 with the Red Camera, which provides gain=1.48 and read noise=3.89.
- Set up the grating and camera angles for your observations. The pre-defined modes are listed in the [Goodman Overview](#) [2].
- You are now ready to use Goodman.

If the data acquisition GUI needs to be stopped:

- Single click on the Main tab and log out.
- Click on the Main tab and Shutdown. This will move all the systems back to their "Home" positions.
- After the shutdown has finished you should ask the TelOps staff to turn off the power to the Goodman electronics box.

A more detailed explanation of the Startup and Shutdown procedures can be found in the [Goodman step-by-step User's Observing Guide \(PDF\)](#). [42]

Starting and Stopping the Data Analysis GUI

The Goodman data analysis VNC window (**soaric7:4**) has a relatively simple layout. If the IRAF data analysis windows are not open, you should see an IRAF button in the lower right corner of the VNC window. Single click on the IRAF button and an IRAF xgterm and a ds9 window will open. Load any IRAF package you may need for your observing. You will also want to make sure that you are in the correct directory to analyze your data.

```
> cd /home3/observer/today/
```

Basic GUI Layout

All observing with the Goodman Spectrograph is handled through the Data Acquisition GUI. Upon successful startup of the Goodman data acquisition GUI on **soaric2**, one should check that the Goodman data acquisition window looks something like that shown in Figure 4.

The Goodman observing GUI can be divided into certain distinct regions as shown in Figure 7. These include the:

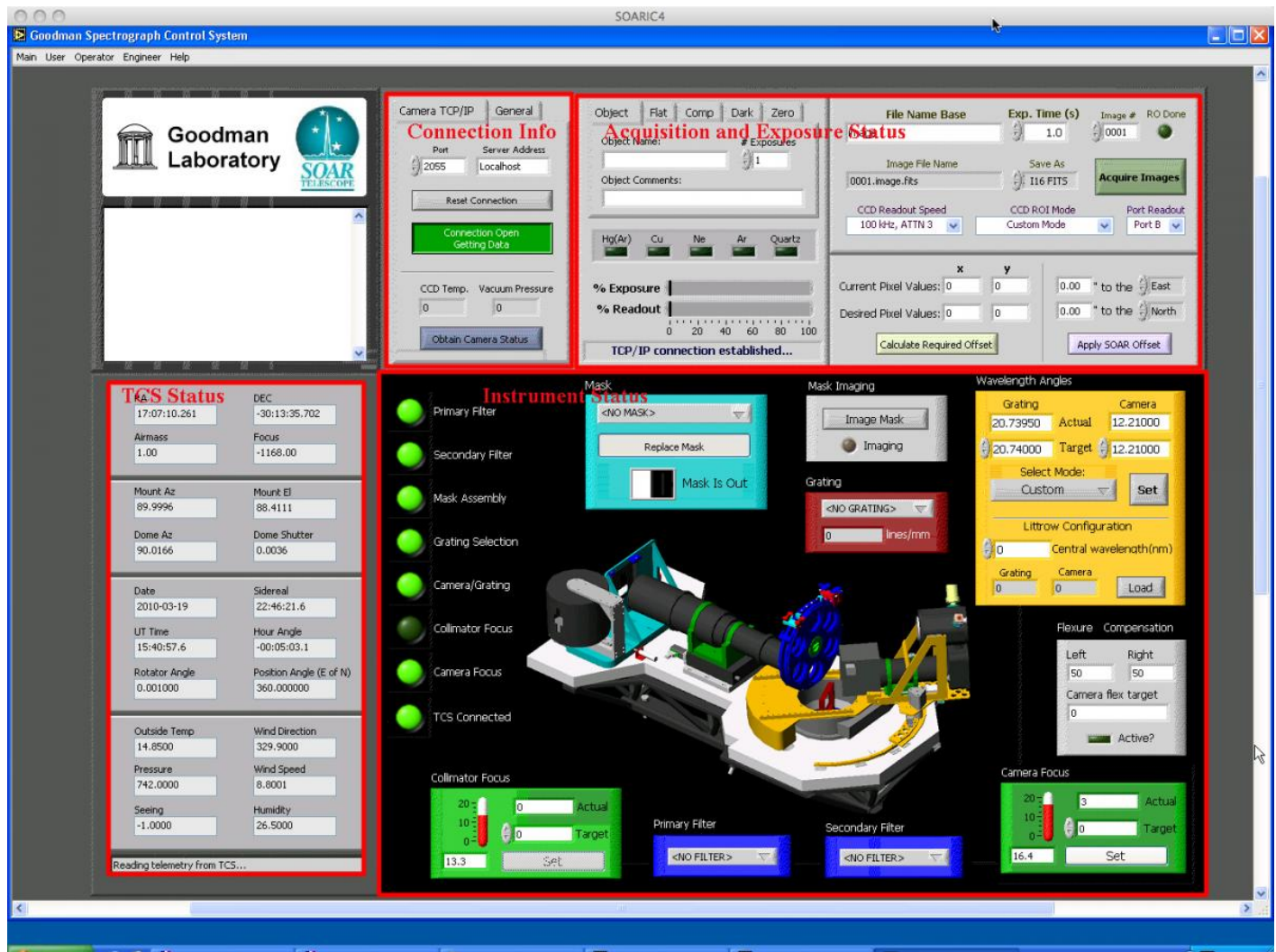


Figure 7: The Goodman data acquisition GUI with regions demarcated and labeled.

- TCS Status Region** - This region shows various telemetry data from the instrument, as well as information obtained from the Telescope Control System (TCS) and the SOAR Environmental Station. These data include the current RA and Dec of the telescope, the airmass, the sidereal time, the ISB rotator angle, etc.
- Connection Info Region** - This region shows if the LabVIEW GSP_Main vi has a TCP/IP connection to the SI Image software. If the connection is active, then you should see a green box stating that the TCP/IP connection is open and that the SI Image software is receiving commands from the GSP_Main vi. One method of checking this connection is to click on the "Obtain Camera Status" button while you are not taking an image. This should update the "CCD Temp." and "Vacuum Pressure" fields above the camera status button. Also included in this section of the GUI is the "General" tab. If an observer selects this, they will be able to edit the "Observer" and "Proposal ID" keywords for the FITS headers.
- Acquisition and Exposure Status Region** - This region of the GUI is complex and contains many items of which the observer should note. In this region, the observer can do the following:

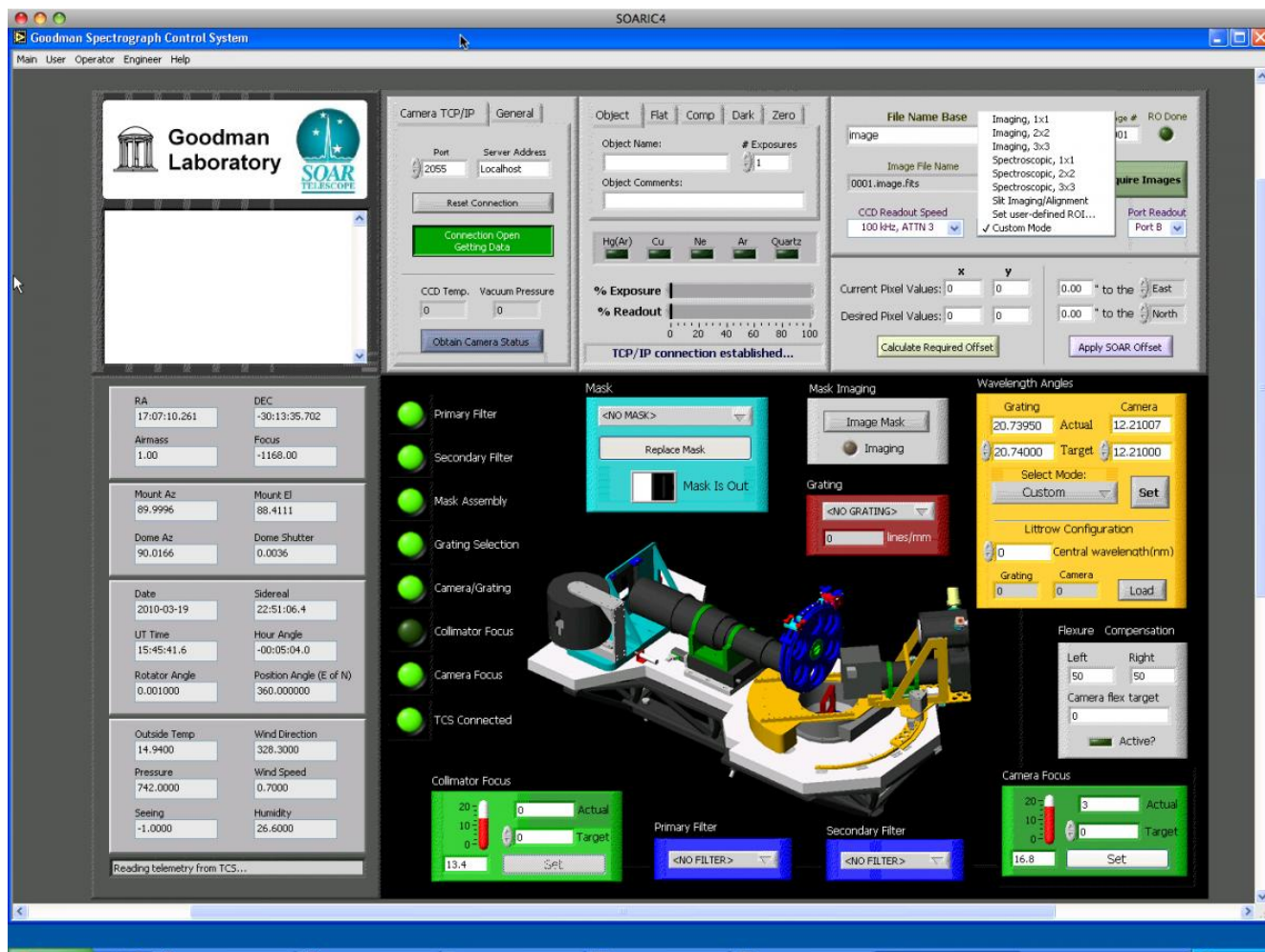


Figure 8: Selecting the CCD binning and image size.

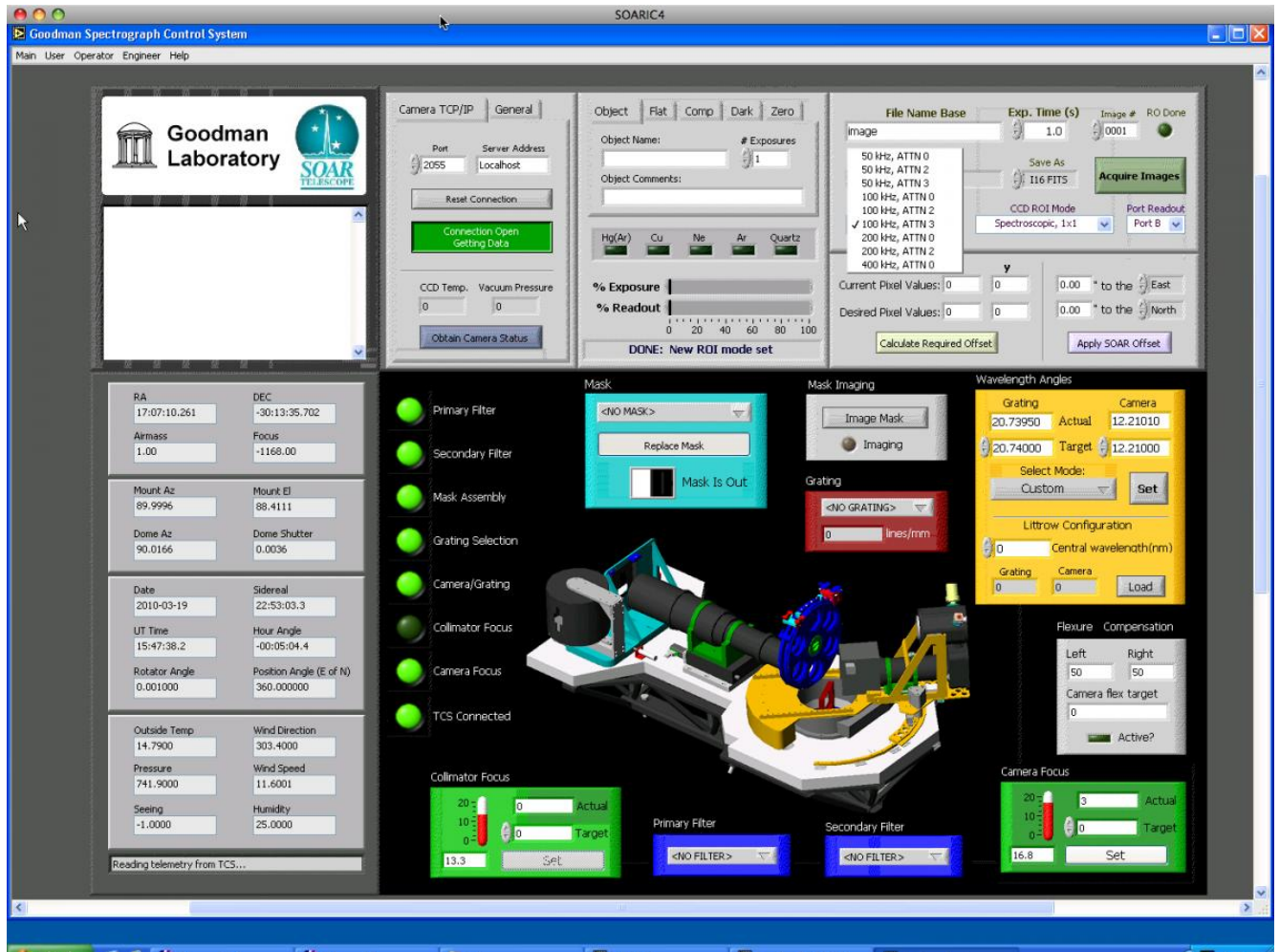


Figure 9: Selecting the Goodman readout parameters.

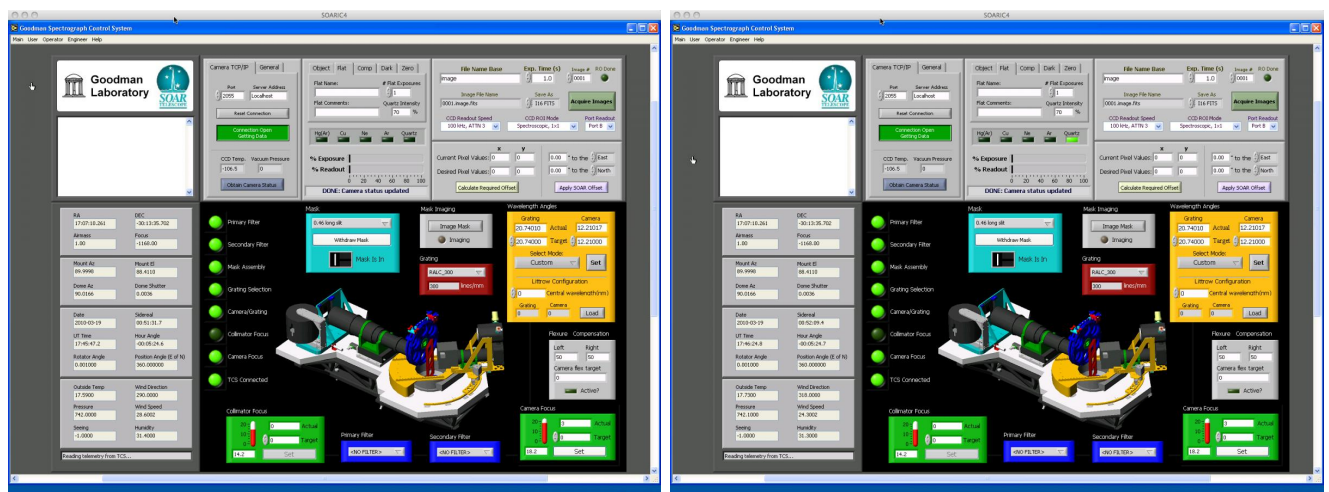


Figure 10: (a) Taking an internal calibration quartz spectrum. In this image the internal quartz lamp is off. (b) Taking an internal lamp quartz spectrum. The quartz lamp has been turned on at the 70% level.

- Change the OBSTYPE (OBJECT, FLAT, COMP, DARK, or ZERO) of the image by clicking on the appropriate tab.
- Edit the "Object Name" for the FITS headers.
- Set the number of exposures for each OBSTYPE.
- Set the base name of the FITS file.
- Set the exposure time.
- Select the CCD binning and image size. The default 1x1 imaging mode has an image size of 3096x3096 pixels. The default 1x1 spectroscopic mode has an image size of 4142x1896 pixels. Please note that no overscan region is written for imaging mode. The overscan region is only read if the serial dimension is greater than 4096 pixels.
- Select the CCD readout speed, gain and readnoise parameters.
- Turn on/off calibration lamps (HgAr, CuHeAr, Ne, Ar, Quartz). For example, select the "Flat" tab in the "Acquisition and Exposure Status" region of the GUI (see Figure 10). All of the calibration lamp LEDs should be dark green (Figure 10a). If you are using the internal quartz lamp, select the desired intensity value and then click the dark green box beneath the "Quartz" label. The dark green box should now be bright green (Figure 10b). You should always check with the telescope operators that the calibration lamp has been turned on.
- Make a telescope offset.
- View the exposure time and readout status.

All of these features will be discussed in more detail in the [Observing with Goodman](#) [51] section of this manual.

- **Instrument Status Region** - This region of the GUI is equal in its complexity as the **Acquisition and Exposure Status Region**. In this section, the observer controls the physical setup of the spectrograph. In this region, the observer can do the following:

•

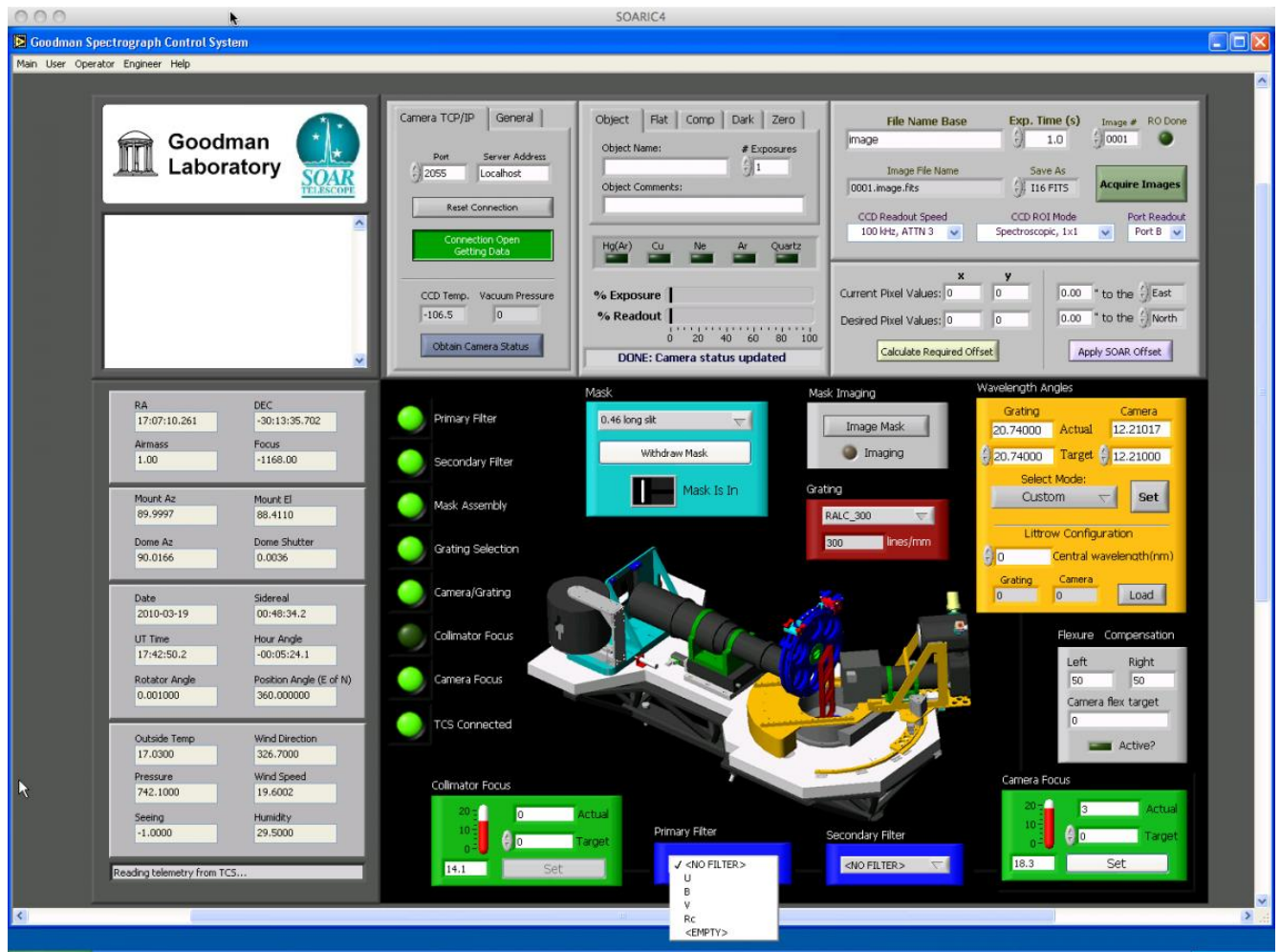


Figure 11: Changing the primary filter.

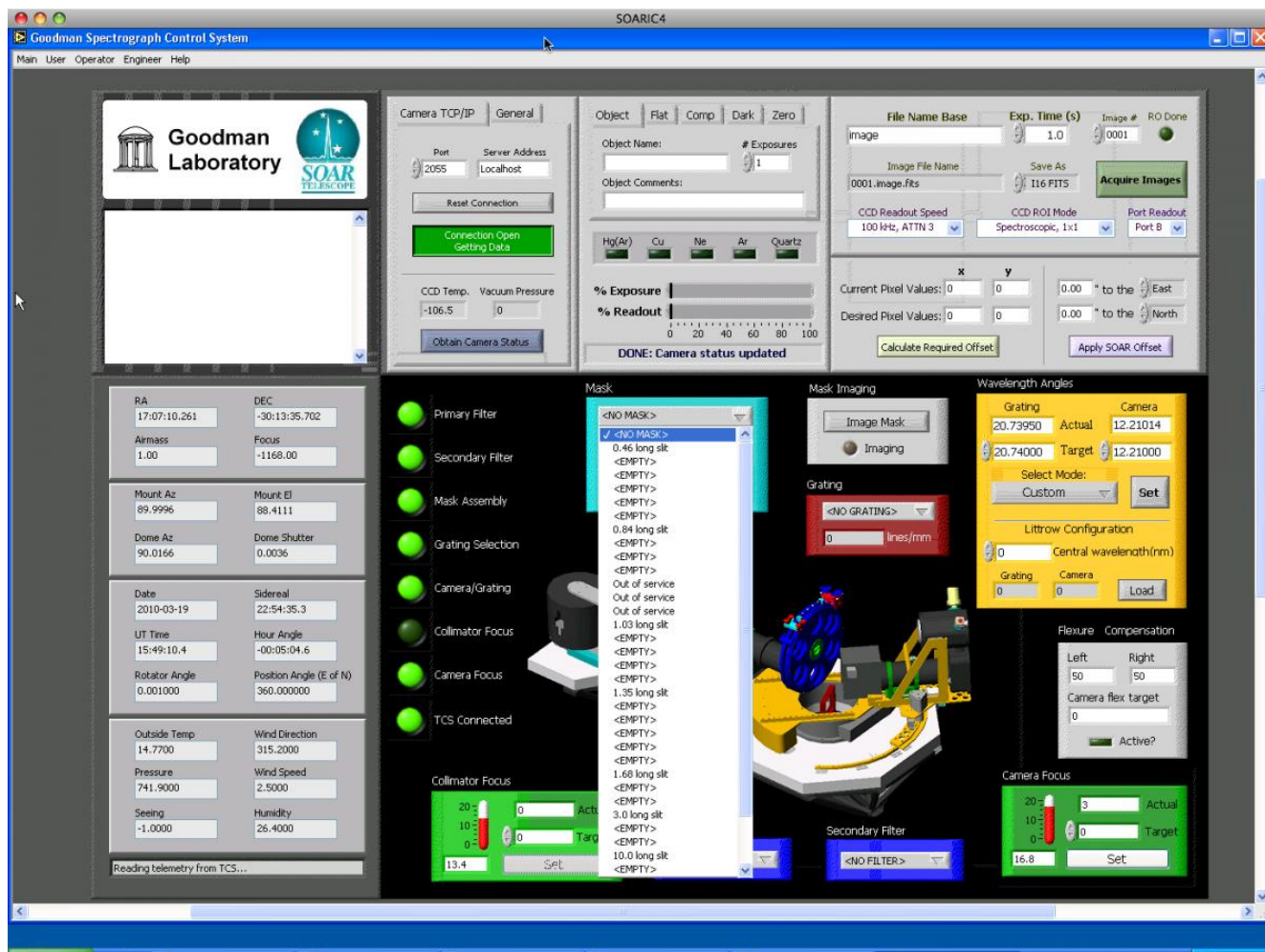


Figure 13: Selecting the slit mask assembly.

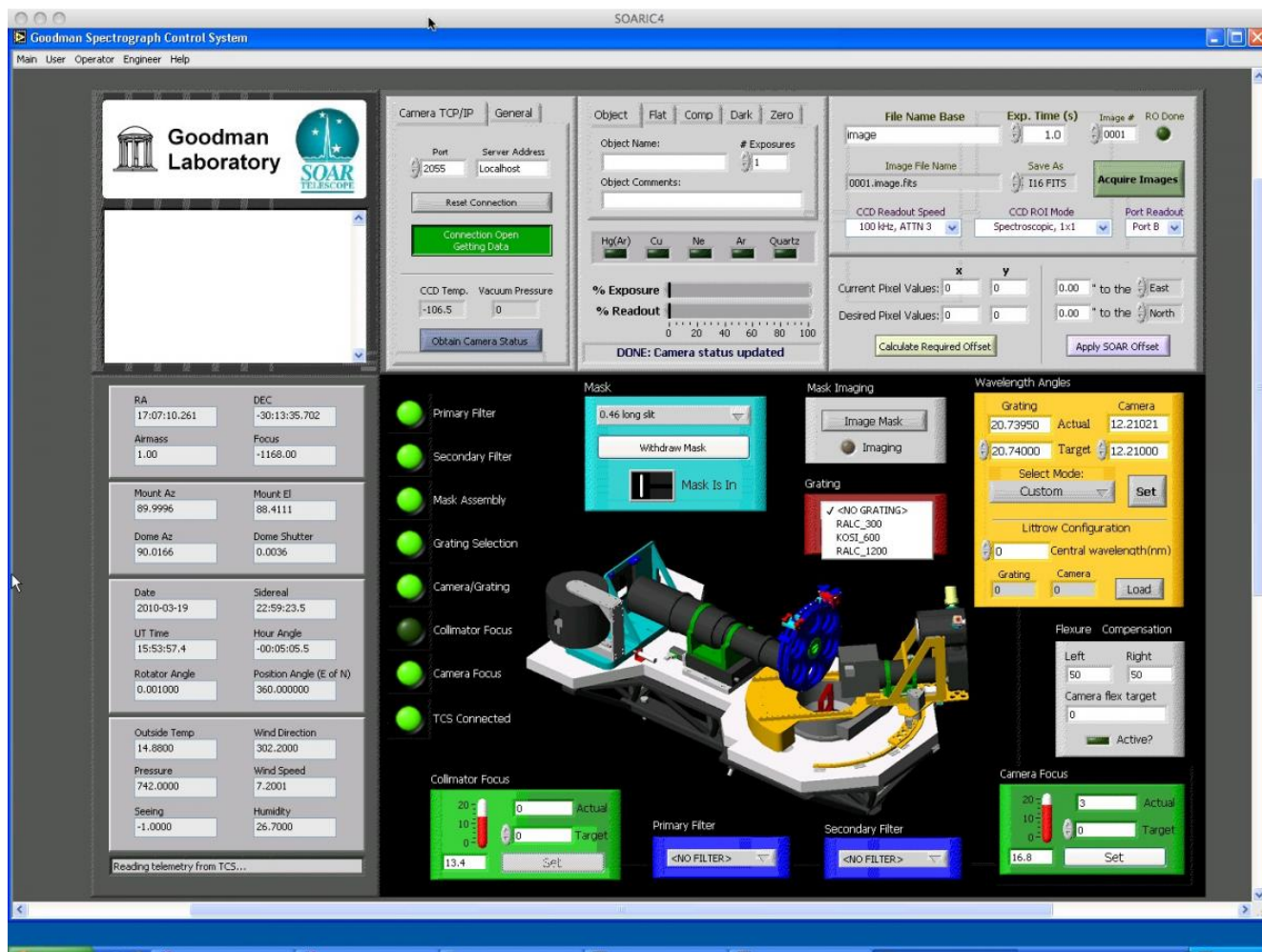


Figure 14: Selecting the grating.

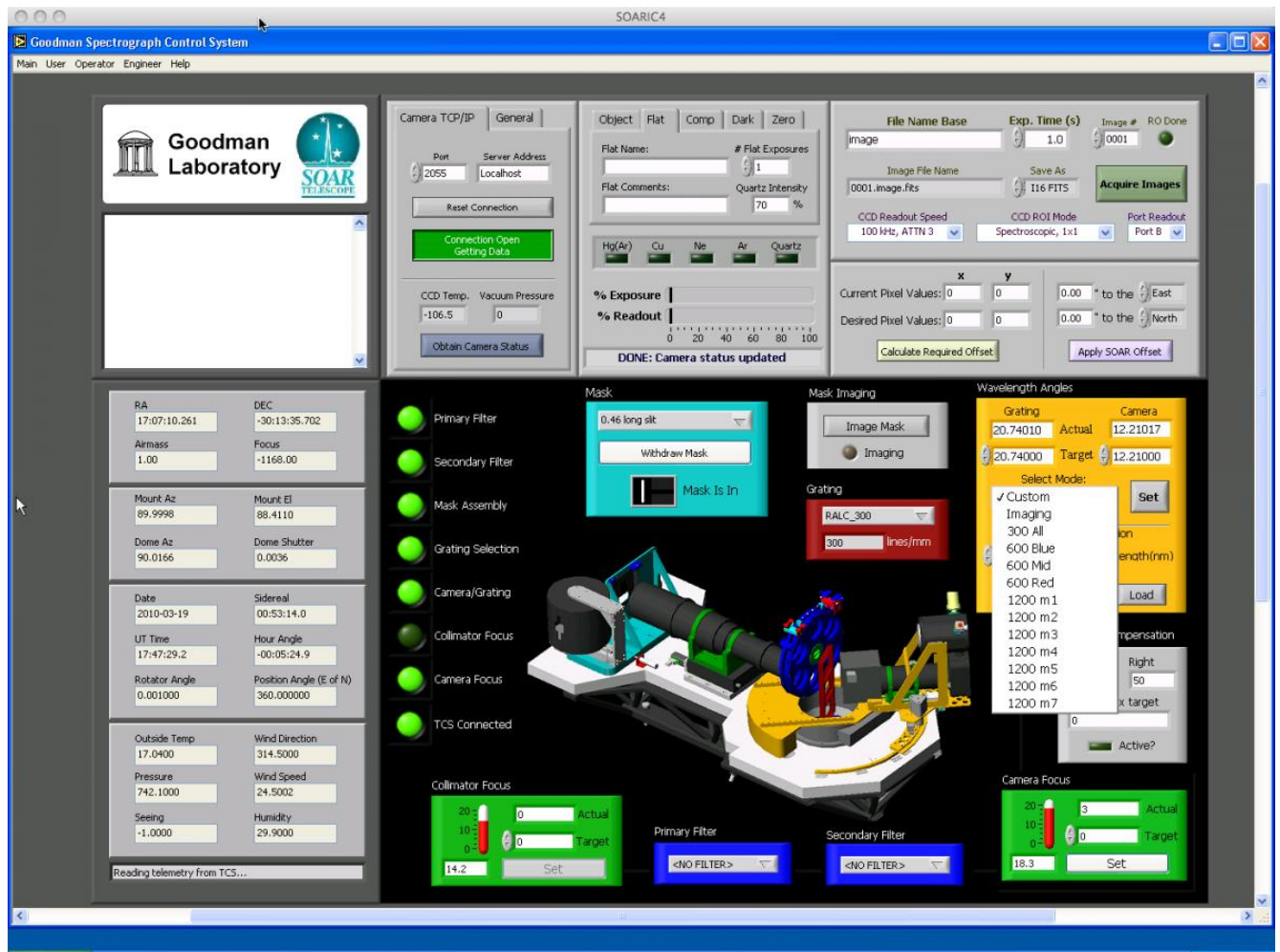


Figure 15: Selecting the camera and grating angles (Wavelength Assembly).

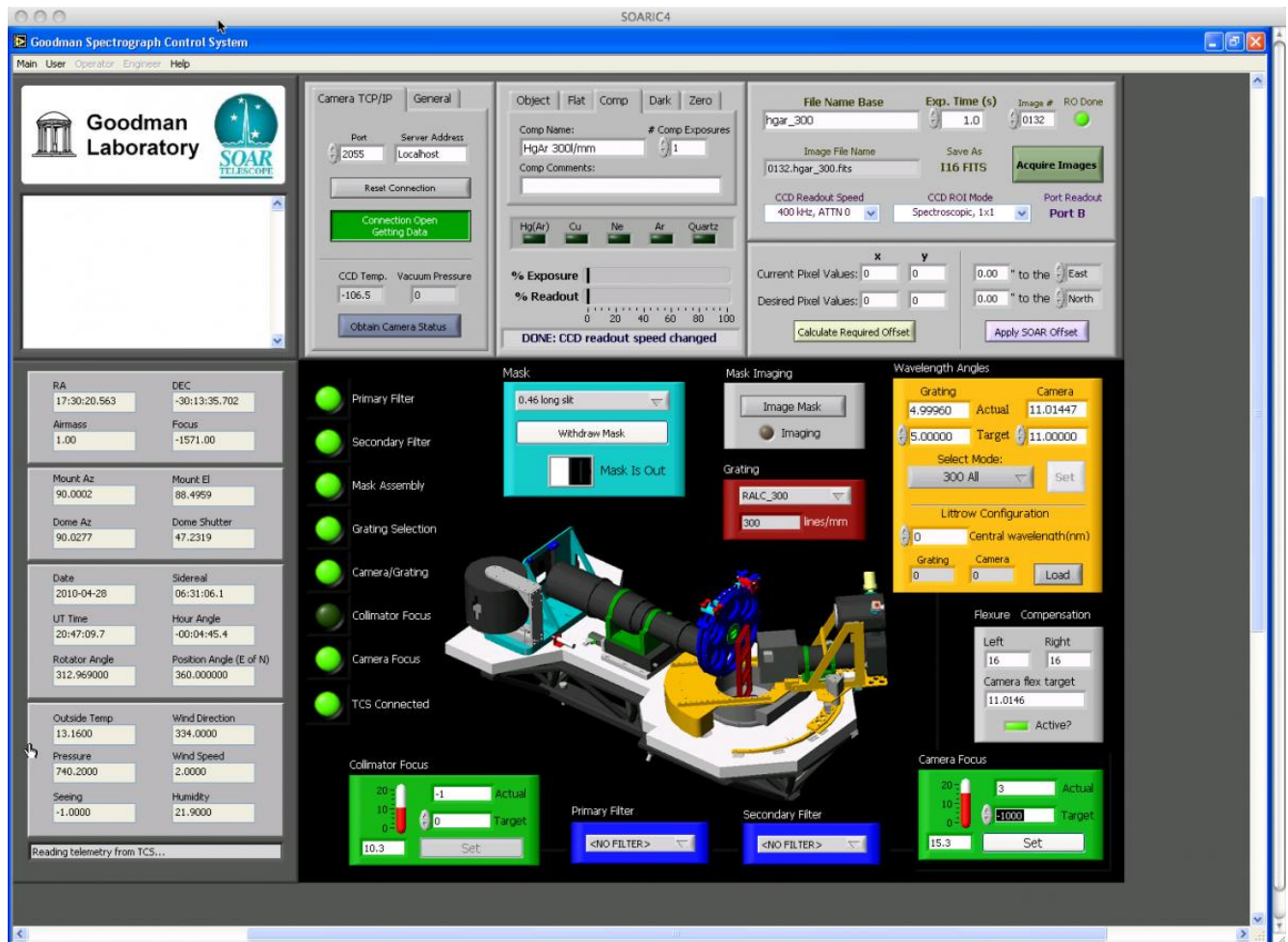


Figure 16: Selecting the camera focus. The set camera focus region is located in the bottom right-hand corner of the GUI. To change the camera focus, the observer should change the "Target" value to the desired camera focus and then press the "Set" button.

- Check on the status of the motor sub-systems. This is indicated by the vertical column of round lights (LEDs) on the left of the display. If the lights are bright green, it signifies that the sub-systems are homed and/or in their proper positions as determined by the sub-displays in this region. If the lights are dark green, it indicates that the sub-system has not been homed. At present, only the status light for the Collimator Focus should be dark green (see below). If the status light is yellow, it signifies that the sub-system is moving from one state to another. For example, if you change the Slit Mask from the 0.46" slit to the 1.03" slit, the light to the left of "Mask Assembly" will change from bright green to yellow and then back to bright green during the exchange of slit masks. If a motor light should be red, it indicates that an error has occurred and that the observer needs to shutdown the Data Acquisition GUI and restarted after the power to the instrument electronics box has been cycled.
- Change the "Primary Filter". The Goodman filter wheels can hold 5 +1 (empty) 4" diameter filters. We have placed UVR filters on the Kron-Cousins system in the primary filter wheel on Goodman (see Figure 11).
- Change the "Secondary Filter". The Goodman filter wheels can hold 5 + 1 (empty) 4" diameter filters. We have placed GG-385, GG-455, GG-495, and OG-570 order blocking filters

in the secondary filter wheel.

- Change the "Slit Mask". An observer can change the Slit Mask from that which is currently in place by clicking on the upper-most button under the "Mask" section of the GUI and select a different slit mask (see Figure 13). After a successful startup of the GUI no slit mask will be in place. The observer should then choose from among our current long-slit masks as given in the [Goodman Overview](#) [2].
- Change the "Grating". An observer can choose from no grating, to any of the maximum of three gratings that can be installed at a given time, e.g., the 400l/mm, 600l/mm, or 1200l/mm by clicking on the grating selection button. For the updated list of available gratings see the [Goodman Overview page](#) [2].
- Select the "Camera and Grating" angles for the observations. This feature allows the observer to select among the various predetermined spectroscopic modes of the instrument (see Figure 15). These modes are listed in the [Goodman Overview](#) [2] section of this manual. We provide examples of HgAr and CuHeAr spectra in the [Comparison Lamp](#) [46] section of the Goodman documentation.
- The "Camera Focus" depends upon the observing setup that the observer chooses. The TelOps staff have a list of the most recent camera foci that have been determined during an engineering run. If in doubt, the observer should determine the best camera foci for their run during afternoon calibrations. More information on determining the camera focus is given in the [User's Guide to Observing with Goodman](#). [24]

(Last Update on May 25, 2020)

Source URL: <http://www.ctio.noirlab.edu/soar/content/goodman-hts-manual>

Links

- [1] <http://www.ctio.noirlab.edu/soar/user/login?destination=node/225%23comment-form>
- [2] <http://www.ctio.noirlab.edu/soar/content/goodman-spectrograph-overview>
- [3] http://www.ctio.noirlab.edu/soar/sites/default/files/GOODMAN/Images/New_Goodman_Cheat_Sheet.pdf
- [4] <http://www.ctio.noirlab.edu/soar/content/introduction-goodman-hts>
- [5] <http://www.ctio.noirlab.edu/soar/node/226/#I1>
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- [22] <http://www.ctio.noirlab.edu/soar/node/228/#S3>
- [23] <http://www.ctio.noirlab.edu/soar/node/228/#S4>
- [24] <http://www.ctio.noirlab.edu/soar/content/observing-goodman>
- [25] <http://www.ctio.noirlab.edu/soar/content/observing-goodman/#S5a>
- [26] <http://www.ctio.noirlab.edu/soar/content/observing-goodman/#S5b>

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[29] http://www.ctio.noirlab.edu/soar/sites/default/files/GOODMAN/Goodman2013_EngVersion.pdf
[30] <http://www.ctio.noirlab.edu/soar/content/observing-goodman/#S6>
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[46] <http://www.ctio.noirlab.edu/soar/content/goodman-comparison-lamps-updated>
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