Sequence Generator Pro--The First Week

Introduction

Sequence Generator Pro makes it easier to get good data from the sky onto your hard drive, the first step in making beautiful images. SGP is a powerful and flexible imaging automation control program that watches over your camera, guider, scope, and mount while you do other things.

Most importantly, SGP is reliable, very adaptable, and can be used with a wide variety of other software, hardware, and resources on the web. The developers have provided an extensive help file that tells what every menu, button, and parameter does.

And this, folks, is where I got lost.

I just wanted it to take over my scope and camera, and take a bunch of pictures for me. (I knew it would not be that easy, but, you know what I mean.) Even after reading the whole help file, I was a bit lost. It was as if somebody handed me the tech manual on the 747 and told me "Here, go fly this across the Pacific." I suppose it could be done. I mean, with the manual, I would know what every button, dial, switch, and gauge in the cockpit did. But what I really needed for my imaging was step-by step instructions for the first night. Something to get me going. Something that said "Do this, then that, then that."

So, if you find yourself in the same spot, here is what I would suggest you do for your first week or so with SGP. (Knowing you, you will probably do it all in one night!)

Overall, this is seven step-by-steps that should lead you to a good background in using the SGP system. Once you have the background, you can go where you want with it.

Night	Task
One	Getting The Computer Ready
Two	Get the Communications Working
Three	Run A Little Sequence
Four	Plate Solving and Pointing
Five	Autofocusing
Six	Meridian Flips
Seven	Your First Full Sequence

A note about the methodology here. "In order to illustrate a point, you have to omit a lot, and exaggerate a lot," the British journalist Bagehot once said (approximately). And this tutorial omits a lot. Sequence Generator Pro allows you great flexibility and great choice of equipment. *This tutorial does not*. It assumes you will use SGP, PlateSolve2, and PhD2 Guiding. By doing that, we can illustrate simply with a common set of information. To do otherwise leads us into a bewildering path of "If you are using.....do this, but if you are using .....do that." We want to avoid this for the first few days. After you are comfortable with the concepts, you will find it easy to move on to other software choices. Secondly, this is the tutorial for those who really are starting from scratch, and who may not even be comfortable with a computer. If you know your equipment, and you are happy forging ahead, go for it. Most folks are up and using ninety per cent of SGP within their first few sessions. This tutorial is for those who want a little accompaniment on

their journey.

We will not take the frontal approach you usually see in software. The frontal approach has you set everything up, and start the program. That is great if you are lucky, and have every parameter and switch pretty much right. But if you do not, when it fails all you know is that "It didn't work." Instead, we will do what Joshua did at Jericho. We will walk around the city once, blow a horn, then again, then again, until in seven days (nights) the walls of ignorance fall down. In short, instead of configuring everything and then taking off on a full blown imaging session, we will install a little, and check a little. Do a little more configuring, and a little more testing. When something isn't working, we will know what step went wrong. Building on one success after another, you will become a Sequence Generator Pro!!!!

Good luck.

Note: this tutorial was originally written in late 2013, with software release 2.2.8. In September, 2016 at release 2.5.2, I rewrote it to reflect the improvements that the developers, Ken and Jared, had made. Then, they made a substantial revision in the icons and made the screenshots obsolete. This effort, version 3 started in May, 2017,uses 2.6.021 and updates those screen shots.

Note2: This tutorial is no substitute for the excellent information in the help screens and manual provided by the developers. Please familiarize yourself with those resource. This limited tutorial is only a little hand-holding exercise to get you started on the basics.

Night One: Get your Computer Ready

You will need a computer that runs Windows. Lots of speed and memory are always nice. But, anything that will adequately run a Windows (7 or later, but you really should be at 10!) program should do the job. Before starting the downloads, be sure to update your operating system and so forth. Simply use Windows Update. And if any of the software downloads ask you to install a more recent version of something (like the network software, or visual basic) do so.

Download and install the software that SGP will need to conduct a session. What exactly you need will depend somewhat on your equipment. This list assumes you will use PlateSolve2 and PhD2 Guiding to get started. Later, when you get familiar with SGP, you will be able to make other choices. All of the programs listed (except SGP itself) are available without cost. Even SGP has a liberal free tryout period. For now, **DOWNLOAD AND INSTALL THE FOLLOWING**:

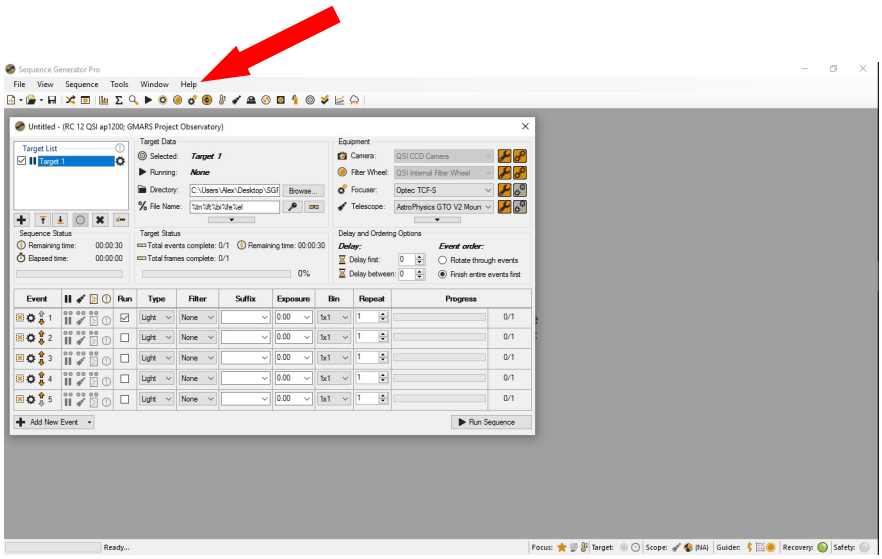
Sequence Generator Pro http://mainsequencesoftware.com/Releases	Download the latest production version. It is at the top of the list. Skip the Betas and the older versions for now.
PHD2 Guiding http://openphdguiding.org/downloads/	Download the latest version. If you have not used the program before, try it out without using SGP until it works on your equipment, and you become somewhat familiar with it.
PlateSolve2 http://planewave.com/downloads/software/	From the wonderful folks at PlaneWave Instruments, we are provided a fast and free plate solver. A version of PlateSolve2 downloaded with your copy of SGP. (Do not download the program itself from Plane Wave.) You should download both catalogs from the website and tell the program where they reside on your computer (see page 56 or so of the SGP manual).
ASCOM and Drivers http://ascom-standards.org/	You will need the ASCOM Platform, and various drivers for your system. If you are not familiar with ASCOM, poke around the site a bit. ASCOM is the *interface* allowing a great number of software programs to communicate with a huge variety of astro equipment. Make sure ASCOM works with your installation.
Astrometry.net local http://adgsoftware.com/ansvr/	On the webpage, see full instructions for installing and configuring this backup Plate Solver. (It takes forever!!! to download the catalogs) You can also use the original remote version of Astrometry.net if you have an internet connection.
Drivers and control software for your own camera, mount, focuser, guider, rotator, and other equipment (Sources vary depending on your setup)	Software, and especially drivers, are required for your setup. Some of this will come from your equipment manufacturer, others from ASCOM.

Note that in several places above it says to try out the software, drivers, ASCOM platform, and so forth. As far as guiding, plate solving, ASCOM connections, or connecting to and controlling your equipment, NEVER EXPECT SGP TO DO ANYTHING YOU CANNOT DO WITHOUT SGP.

When you have the software installed, **OPEN SGP FOR THE FIRST TIME**.

You should get a screen that looks something like this:

You may want to look the screen over, just to familiarize yourself with the general presentation. But, really, we will not be using most of these subframes for the first week. We will call those we want when we need them. So, in the



meantime, you can close them by clicking on the “X” in the upper right corner of the respective windows.

On the main screen, click on "Help,"/"Help File." And **READ THE MANUAL.....**

Really, RTFM (I think that engineering acronym stands for "Read The Fantastic Manual").

(You know, that line was in the first edition of this tutorial. Since that first edition was written three years ago, Ken and Jared have substantially strengthened the manual. Some sections of the help manual are so much better that had they existed back then, I would not have spent the time to write this tutorial!!!!)

Get an overview of what is about to happen. RTFM. The manual may not make complete sense, yet, just as reading a dictionary will not really tell you how to write. But it will tell you about possibilities.

When you are finished with the SGP manual, be sure to check out the PhD2 help screens, the ASCOM website, and the PlateSolve2 help screens to see what they are about. If you do not already have PhD2, and the others working with your system, get them working independently of SGP. Never expect SGP to automate something that you have not gotten to work in the first place.!

That will be about the end of the first evening with SGP.

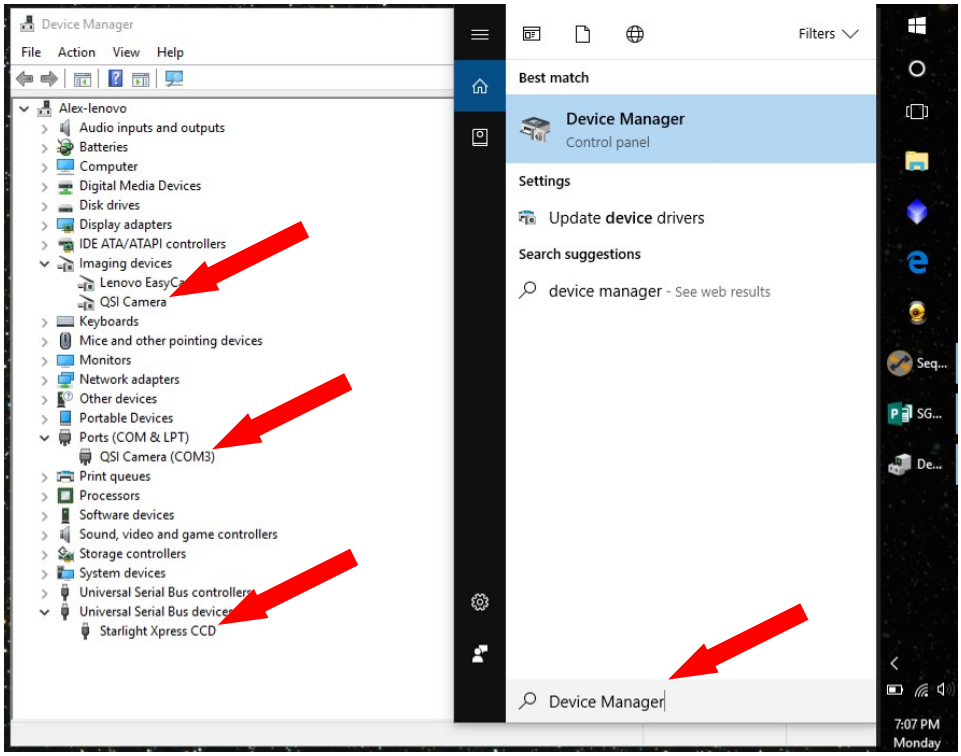
Night Two: Get the Communications Working

If you have been imaging with MaxIm, CCD Commander, AutoPilot, or any one of a number of other command programs, you will have an easy time tonight. You are simply going to make sure SGP knows where all the equipment is, and how to communicate with it. As a matter of fact, if you have been working with the other programs, you probably would not be reading this tutorial.

Many SGP beginners think they have a problem getting started with SGP when in fact they are having a problem with the equipment or the communication with their equipment. It has nothing to do with SGP, but SGP gets the blame. Never expect SGP to do something that you cannot do manually. Things like picking the right port, or having a cable function properly are beyond the control of SGP. So, get them working first, before asking SGP to automate them!!!

It is a good idea to read through this section before attempting any of it. The second part especially, about configuring the SGP equipment profile, involves knowing a bunch of information about your system (focuser step size, number of pixels, image scale, etc.). You want this information on hand before sitting down with your system to enter it.

The main thrust of this evening is to make sure the devices are working and communicating with your computer. Then, you need to tell SGP where to find the devices. This can be done on a dark and stormy night. Or during the day. Do this in your living room if you like. Do not wait for a dark, clear night. You will not be taking pictures yet. So, **set up everything you plan to use.** Power the devices up if they have separate power supplies, but don't plug them into the computer yet.



Windows has a record of which equipment is where, and what ports, USB connectors, or whatever is working with it. It shows all this in the "Device Manager." In older version windows, you can find it by clicking on the start button, and looking for Control Panel/Device Manager. In Windows 10 click on the "search" magnifying glass icon and type "Device Manager" into the search window. **Start the Device Manager** and see how it lists all the objects you have out there. You are interested in Imaging Devices, USB ports, USB to Serial adapters and PORTS.

Now, **plug in your camera**, and see that it shows up in the Device Manager. You should hear a beep, perhaps see some messages about loading drivers for the device, and such. Then you should see the addition in the Device Manager. Your camera name will probably now be there, or it could say something generic like "Block I/O device." But when you plug your camera in, something in the Device Manager should change. If it does not, you need to re-install the drivers, or whatever it takes to run the camera. That is beyond the scope of this tutorial. (And the same admonition goes for the other devices in this section.....You need to get all the equipment talking to the computer before you ask SGP to talk to the equipment.)

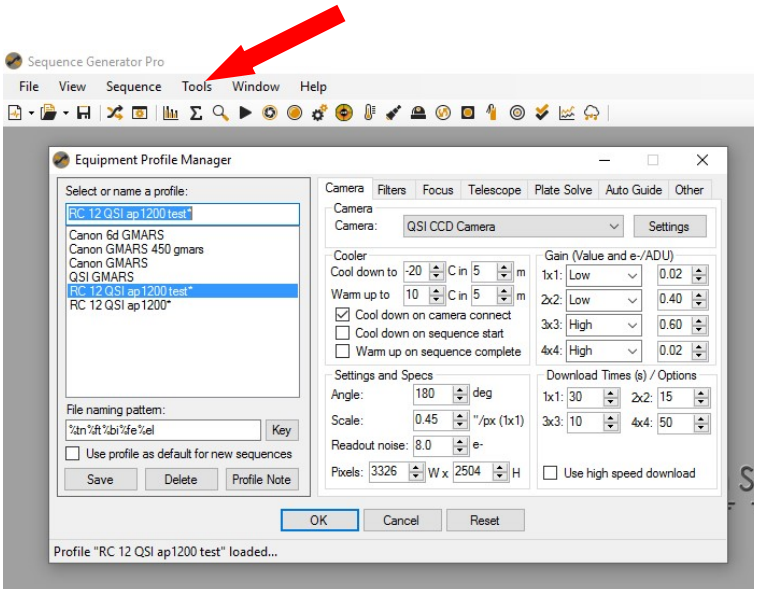
Then, **Plug in your guider**, and see that it shows. Same thing as with the imaging camera.

Next, **plug in your mount**. And, of course, see how it shows up in the Device Manager. Your camera and guider were probably on USB ports. Your mount and other equipment, however, may well come on a USB to serial Adapter. So you could get two entries. One will be the USB device name, and the other a PORT number. **Record the port number.** If for some reason port numbers are not showing up, click on the "USB to Serial Adapter" entry, and click "properties," and "advanced."

Then, **plug in your other devices one by one** and see that they show up in the Device Manager. For anything on a serial port, or a USB to Serial Adapter, **record the port number** of the device. These additional devices include your focusing motor, filter wheel, and rotator. If you are not using these other devices, you can skip this part.

If you lose track of which device is on which serial port, you can simply unplug it, and the device will disappear in the device manager. Plug it back in. Note what changes.....

If everything has gone right, you should have all of your equipment installed on your computer and be able to communicate with it. And you will have notes on which device is on which port. So, let's test.



Power up all your equipment, and **run your mount through its alignment routine** Even if you are indoors--just pretend that it is in fact pointing where it says it is pointing. If you did what was in the preceding paragraphs, everything is connected, but if it is not, connect and power everything up before starting this step. If you are using a DSLR, be sure to disable its "Sleep" function. You do not want it turning itself off in the middle of all this.

A note: Always try to connect your devices the same way. It is easy to confuse Windows by plugging a device into one USB port one day, and a different one the next. Usually it keeps them straight, but at other times, and especially with USB to Serial adapters, it gets confused. To do this, label your ports and your cables so that they always go in the same jacks in the same order!

And, now, let's put SGP to work. **Start SGP.** When it starts, it will come up with a blank sequence. Ignore it. The first thing we are going to do is **make up an Equipment "Profile."** A profile keeps all the information about you and your equipment nice and orderly, and keeps you from typing the same stuff in night after night. Under Tools, select "Equipment Profile Manager." (Either the pull down menus or a Ctrl-P will get you there.) Click in the box and enter a name for the profile.

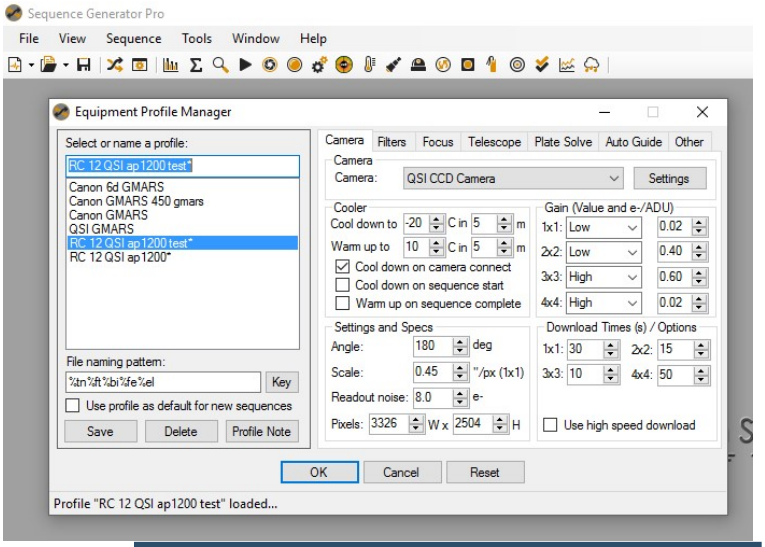
Notice the tabs ("Camera, Filters, Focus, etc.") along the other side of the window? The next job is to click each of those in turn, and complete the information.

If you have not noticed it yet, hovering over an input box will light up "Tool Tips." (If you have not seen Tool Tips, go to Tools/Options/General Options and make sure "Show Tool Tips..." is checked. Pay attention to Tool Tips. I will not repeat the information they contain.)

Click on "Camera", and complete the information using the pull down menus and input windows. Click on the "Settings," and configure ports and other information.

All of this input data (Gain, Angle, Readout Noise, and High Speed Download time) can just use the defaults for now. They are used in other parts of the program that we will not need this first week. But you must specify the following:

...(if you have a cooler), CHECK the "Cool Down on Camera Connect." and enter settings for Cooler Temperature, setting it at -10 or -20 (or whatever your manufacturer suggests) in 10 minutes for cool down. But, until you get good at this, leave "Warm Up on Sequence Complete" UNchecked. (You will be making some mistakes, which will require ending a sequence. If your cooler shuts down as part of the "sequence ending routines" each time, it will get very annoying.)



...Under "Settings and Specs," you should set the "Pixels" and "Scale." Accuracy on the "Scale" is very important. This information is used by the Plate Solving program later. Bad input here can render Plate Solves impossible. "Scale" is how many arc seconds of sky each pixel sees at 1x1 binning. If you do not know what your scale is, use the Starizona website http://starizona.com/acb/ccd/calc_pixel.aspx . For instance, a QSI 583, with a Televue NP 101 (540 mm focal length) telescope has a scale of 2.06, and 3326 x 2504 pixels. Enter the numbers for your system. The settings for my QSI 583 with 3326 x 2504 pixels and an image scale of .45 arc seconds per pixel (with my 12 inch RC) looks like the image at right. Other information is optional at this time.

...If you have a mono camera, using a filter wheel, **Click on Filters**, name your filter wheel, and click on "Set Filters." Pay attention to the Tool Tip advice unless you know your system better. For now, you can skip the Focus Pt and Flats information.

Click on Focus tab and complete the information regarding the name of the focusing motor/system, Fine and Coarse step sizes. Under Fine Focus Step Size, enter a number that is about half of your Critical Focus Zone (as expressed in focuser steps). Under Coarse Focus Step Size, enter a number about twice your Critical Focus Zone (in steps). Don't know what your Critical Focus Zone is? This needs to be calculated for your system. By now you should have read the Help File on Focusing/AutoFocus/Understanding Auto Focus. Pay attention to it in determining your focuser step sizes. On the focus window, leave the boxes unchecked. (We won't be using Autofocus for a few nights.)

Click on Telescope, and choose your driver/scope combination. Click on the "Settings," and configure ports and other information. You can take the defaults on the other information or configure it for yourself if you know better. However, UNcheck all of the control boxes for now.

Profiles and this Tutorial

Profiles are very powerful. But with power comes responsibility. This tutorial is neither powerful nor responsible. We are just trying to get through the first week.

Profiles are tools so that we do not have to re-type different configurations of equipment, location, and software every time we build a sequence. But, instead of saving work, they can cause confusion for some, especially since you can change configurations without changing the profile, and changing the profile does not necessarily change sequences....see--I told you it can be confusing.

We eliminate most of the confusion because we assume you have only one equipment profile this first week. To get through the first week, we omit talk of the User Profile, multiple profiles, making sequences from profiles, saving profiles as sequences, and a whole lot of other profile related topics. And every time we change something in our configuration, we will start with a new sequence. That is not true once you learn how to use profiles completely. But it is for now.

All we need this first week is one simple Equipment Profile, and that is all we are making. You can learn other aspects of Profiles as you progress.

Click on PLATE SOLVE and set up the information. Click on the "Settings," and configure ports and other information. In this Tutorial, we assume PlateSolve2, and take the defaults on it. (Be sure you have installed the two guide star catalogs and told PlateSolve2 where the catalogs are on your computer.)

If your camera uses filters, check the box and tell the configuration screen you want to use Luminance. Check the "Use Blind Solve Failover" box and under "settings" choose ANSVR (Local). (If you chose not to install ANSVR, you can check Astrometry.net, but you will need an internet connection at your imaging site to use it.)

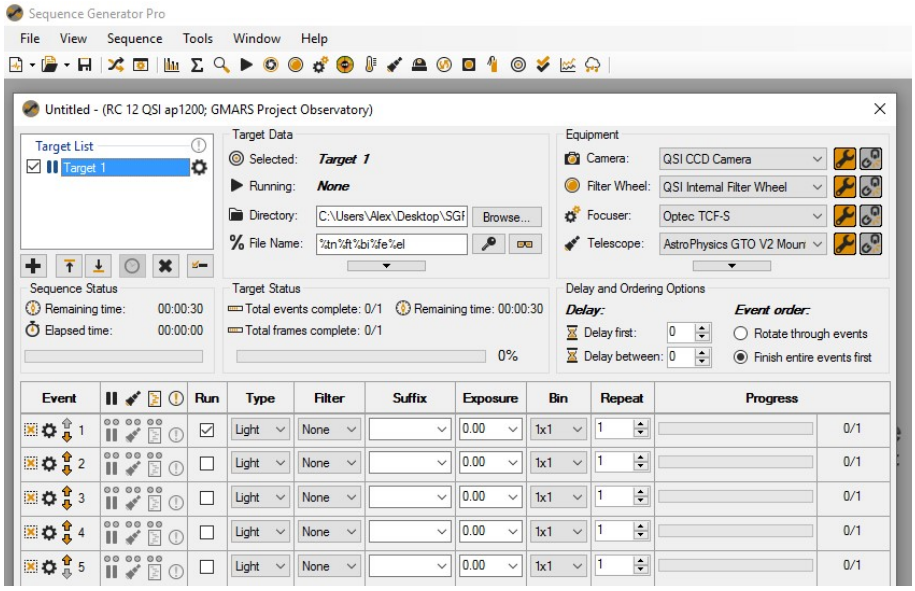
Click on Auto Guide, and choose PHD2. Click on the "Settings," and configure other information. CHECK Dither, and pick High Dither if your scope is under 1000 mm focal length, and Small Dither if you have more focal length. Tell it to "Settle At" 2 pixels, CHECK the box in front of "For," and set the window to 4 seconds. CHECK "Stop when sequence completes" and "Pause Guiding during Autofocus." UNcheck the other command boxes. Take the defaults on the number parameters unless you know your system better.

On the Autoguide window, click on "Settings" and identify where PhD2 is installed, and which equipment profile you are using with it. CHECK the "Open and Connect" box, but UNcheck the Disconnect box until you finish your practice runs. *You should be familiar with the operation of PhD2 Guiding. If you have never used it to guide your rig, take some time before using SGP to do so. SGP can only start, stop, and sometimes dither with PhD2 Guiding. ...If PhD Guiding is not configured and operating correctly on your system, SGP cannot fix that.*

You can leave "Other" tab alone for our purposes. Remember, we are just trying to get through the SGP basics!!!

One more thing before we save and quit the Equipment Profile window. On the left side toward the bottom of the window, **CHECK the "Use profile as default for new sequences" box.** Now, when you make a new sequence, it will know what equipment you plan to use. If you change something in this configuration, you must start a new sequence to incorporate the change.

Click Save, and CLICK OK in the bottom of the Equipment Profile Manager, and the program will guide you through saving the sequence.



We are ready.

Your equipment should all be connected and powered on.

You will note the "Tool Bar." If for some reason it is not showing, pull down the "View" Window, and click on "ToolBar."

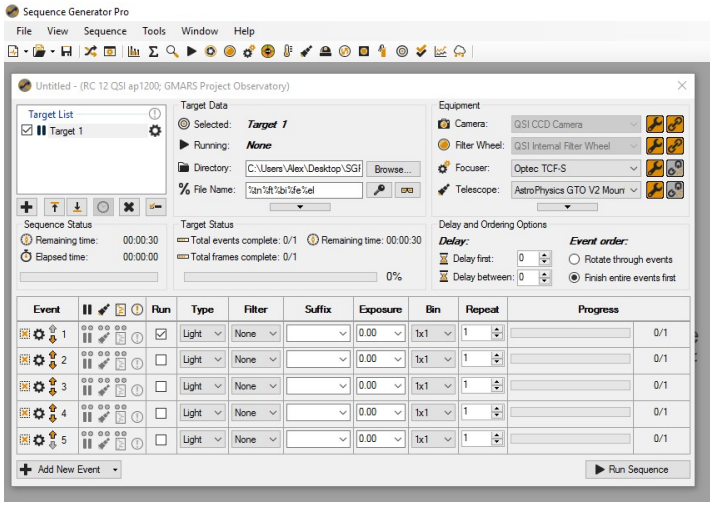
On the extreme left of the Toolbar is an icon that looks like a orange line graph on a white page. It stands for "New Sequence." A Sequence is a collection of parameters, and a set of instructions to go along with it, that, taken together, define which equipment is to take what action in what order in order to complete a job.

Click on the "New Sequence" Icon. Up pops a very important looking window. And each detail on it is important. But, for now, we are only going to worry about one little part of it. In the Upper right quadrant, you will see the

"Equipment" section. It lists the Camera, Filter Wheel, and such that you just entered in the profile. If it does not, check back on the work earlier this evening under Equipment Profile."

Next to each piece of equipment, is a wrench (setting)icon and a chain link (connect)icon.

Click on the Connect Button next to the Camera. If you have done everything right, the gray box turns orange (and the link becomes whole) as your camera is connected.



Click, one by one, on the other Connection Icons, and watch them connect and turn orange. (Filter wheel is available only on cameras so configured.)

(If you had configured a light box for flats and a rotator, they could be accessed with the little pull down below the telescope window.)

And if something showed up an error? If a gray box did not turn orange? It is most likely something simple. It may not be powered on, or may not be connected. Or, there could be an error in the configuration. Connected to the wrong port? (Check the Device Manager or refer back to the information you recorded in the Equipment Profile as to which device is on which port.) Driver not loaded? Work through what it is until you get the connections you need.

You really should be doing all this for the first time at home in a well lit living room, but if you are using a red screen at a dark site, it is hard to tell if the icons have changed to orange! The orange “connected” icons have connected links, that were not connected when the icon was gray.

If all the gray connection icons turn orange, congratulations. You are connected and configured. Tomorrow night, we take pictures!!!!

And if they did not……well, go back to the device manager and see that the devices are out there. Check power cords, cables, port configurations, and such. Re check what you typed into the equipment configuration profile in this evening’s work. Check your ASCOM device interface programs, and get your stuff to communicate with them before asking SGP to hook up with them.

But, do not proceed.

You would be asking SGP to do something it cannot do—run equipment it cannot find.

Night Three: Run a Little Sequence

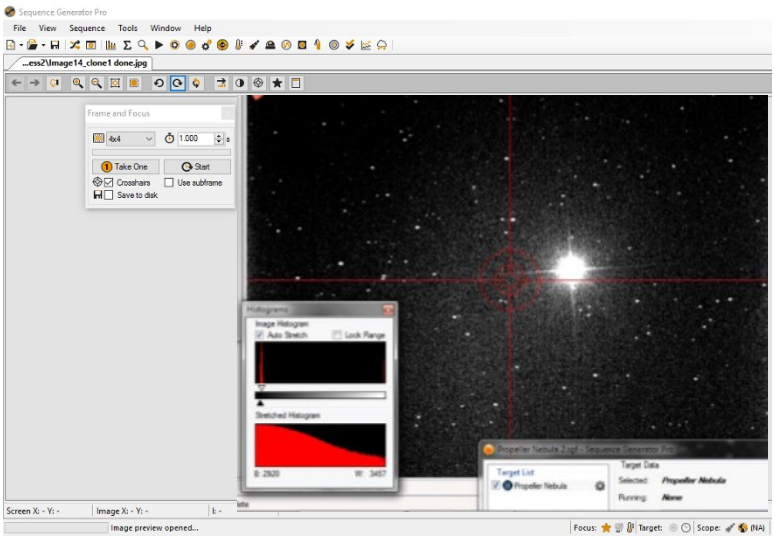
This evening, we finally take a picture.

Start by **setting up outside under the stars**. Don't wait for a dark sky site, a moonless night, or even a cloudless one. Do this in your back yard under whatever conditions you have--as long as you have some stars showing. Certainly do not wait until you get to a dark site! Do your practicing at home under whatever skies you have. That way you will be ready to go on a dark night far from the city!) Get everything ready and comfortable: Computer, power, equipment balance, cable routing, polar alignment, sky synch, finderscope (if any) aligned with main tube, and all. If you know (from other software or whatever) where your camera focuses best, set the focuser to that position. (And take a picture with your other software to get things focused and the object centered if you can. Be sure to disconnect that other software before asking SGP to take over!!!)

Next, using your mount's goto or handpaddle, send your mount to a *known bright star* about thirty degrees before the meridian. In other words, go to a bright star high in the eastern sky. (There is nothing magical about that location, it just makes it easier to play with things. If you have clouds in that portion of the sky, point to some other known bright star.) By "known bright star" I mean something bright and identifiable to the naked eye, something you know the coordinates of, and something that will be obvious in the scope and usable with a Bhatinov mask. Again, if you have other software that runs your camera, you can use it to get you there, centered, and focused.

Run through the last part of last night's lesson. **Start SGP, and connect all the equipment** so that you have orange "Connection" icons on the "Equipment" portion of the sequence window.

Click On the Frame and Focus Icon. (The tenth icon over on the toolbar, the one that looks like a camera lens iris) . Up pops the "Frame and Focus" window. Set your favorite binning and exposure. Check the "CrossHairs" box, and **press the "Take One" button.** A few seconds later you should see a picture of your bright star, and probably a few celestial friends. But it needs to be centered and it needs to be focused. (You may want to experiment with the binning, ISO, and exposure time while you are here. You must see some stars at this point, so adjust away until you do.)



If you do not see a picture of stars, you may have forgotten to remove the cover on the telescope!!! Or, you may be way out of focus. Or, you may need to "Stretch the data." To stretch the data, click on the "Histogram" icon in the tool bar (The sixth one over, the orange and black bars on a chart) and check the Auto Stretch box.

If your bright star is not visible in the frame, go hunting for it.....If you have a finder scope properly aligned to the main scope, use it and your handpaddle to recenter your quarry. (If even that does not work, you may need to remove your camera, put in an eyepiece, and do the centering….then replace the camera). Then, center using your camera. Change the binning to your highest binning (4x4 or whatever) and fastest download speed. Do not use a subframe. Press "Start" in the "Frame and Focus" window. Your camera will start downloading pictures and putting them on the screen as fast as your camera allows. Meanwhile, with your handpaddle, you will slowly move your scope around the area until you find and eventually center your bright star. (To be sure you are centered, use the "crosshairs. " (Click the Crosshairs box before taking a picture. Or, if you already have a picture displayed, right-click on your downloaded image, and choose "Show Crosshairs.")

choosing your camera and mount and pressing "Connect All." You should see that in the lower right corner the words "Camera" and "Mount" appear. This means you are successfully connected. If you do not see this, review your configuration, your ASCOM picker, or whatever software and drivers you use to communicate with your guide camera and mount.

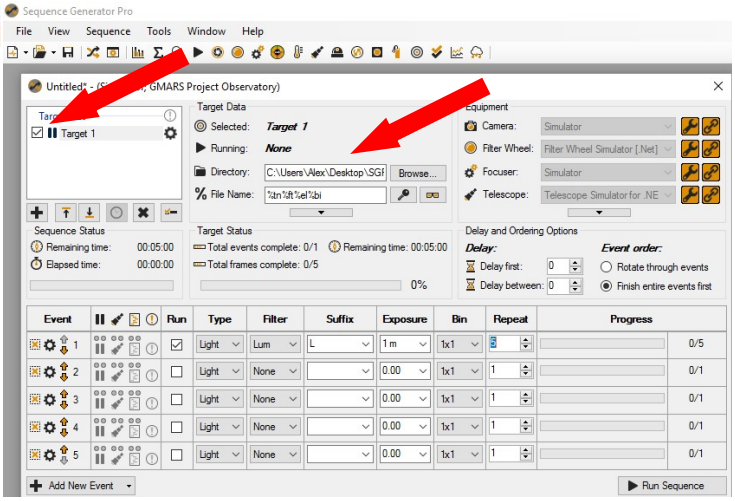
You can change the length of exposure in the appropriate pull down window, and adjust other PhD2 Guiding features using the "Brain" Icon. But for now, the defaults will probably do.

Take a guide image using the turquoise looping exposure arrow to check exposure and focus of the guide star. Focus as needed. (If you are using a separate guide scope, you have a separate focusing control. If you are using an OAG or such arrangement, do not change the main imaging camera focus but work on focusing the OAG. These are things that should have been done before starting SGP…). Select a guide star by clicking on one of the bright stars and **click the PHD (Target) icon** to calibrate and start guiding.

If you have never used PHD Guiding, learn a bit about it. But, really, it should work fine just as it is. That, after all, is how it got its name!!!

Now, leaving PHD Guiding OPEN, go back to the SGP window.

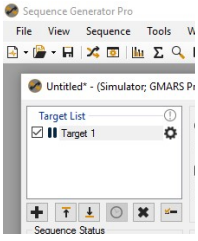
(Once set up, SGP knows how to find and start PhD2 Guiding, calibrate if necessary, and all that without your intervention.)



Open the Sequencer by clicking the Sequencer Icon (the fourth icon over from the left. It looks like crossing orange and black lines). This is the heart of the operation, but we are not going to use it all tonight. You should already have the Camera, Filter Wheel, Focuser, and Telescope connected this evening. If you do not, do so now. (Make the gray connection icons orange.)

Let's set up a sample sequence with just one event. On the first line of the table, make sure there is a check mark on the "Run" box. With a mono ccd/filter wheel, tell it you want your Lum filter, give it the Suffix L, and give it an exposure of 1m. Bin 1 x 1 and tell it to repeat five times. Make sure no other event "run" boxes are checked. If using a one shot camera like a DSLR, your entries will be slightly different, with no filter, perhaps no binning, and perhaps an entry for ISO. Put in the appropriate information.)

In the center of that window, at the top, you will see the Target Data section. It says you are on Target Set 1, and Running is set to "None" for now. Complete the Directory Information. This is the place on your computer where you want to store all your pictures. Click the Browse button and, maneuver through the files, probably making up a new folder somewhere called "SGP Data" (Or a name you prefer). Tell it OK. Accept the default filename information for now.



In the upper left corner of the Sequencer, you will see the Target List. As a default it says the target is "Target Set 1." The gray Cog icon next to the "Target Set 1" brings up the "Target Settings" Window. It is one of the most critical of the whole program. Alas, for us on our third night, we are only trying to make sure we can focus and guide our shots. So, do not click on the "Target Settings" icon. Leave the check mark next to "Target Set 1" on the main sequencer window.

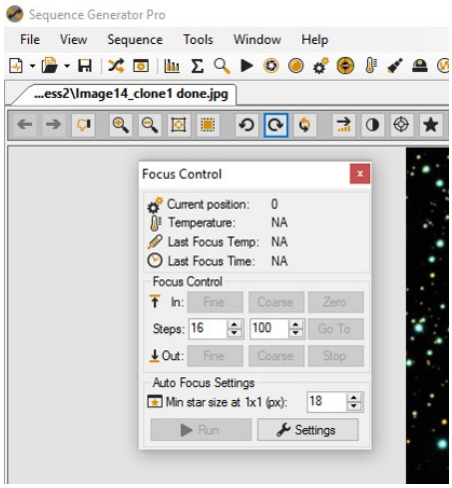
When you get close to centered, it is probably easier to press "Stop" in the Frame and Focus Window. Then adjust position, and press "Take One" and repeat until you have the star centered. Then **synch your mount** on the centered bright star. If you are still gathering frames, press the "Stop" button on the Frame and Focus window. (If your finder was not properly aligned with your main tube, get that corrected now. You may need it later.)

With the star centered, look at the “Frame and Focus” window, and check the “use Subframe.” Draw a small rectangle over the star centered in your picture. From now on, the program will just download this portion of the picture.

If you have a Bhatinov mask, put it on the scope. If not, focus by looking at the size of the star image on the screen.

If you do not plan to use have a motorized focuser with SGP, you will focus by manually moving the focuser. For details on manually focusing, see step 9 in the “Getting Started” at Help/Getting Started/ Mono or OSC-DSLR.

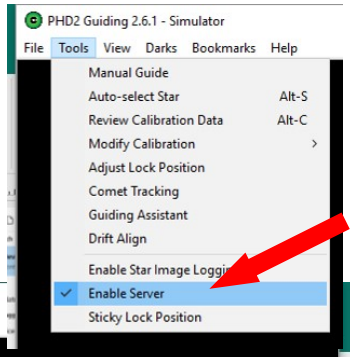
If you have a motorized focuser connected, look to the toolbar and locate the black and orange cogs. This is the "Focus Control" icon. **Click the Focus Control Icon** and you see the current position of your focuser and lots of other information.



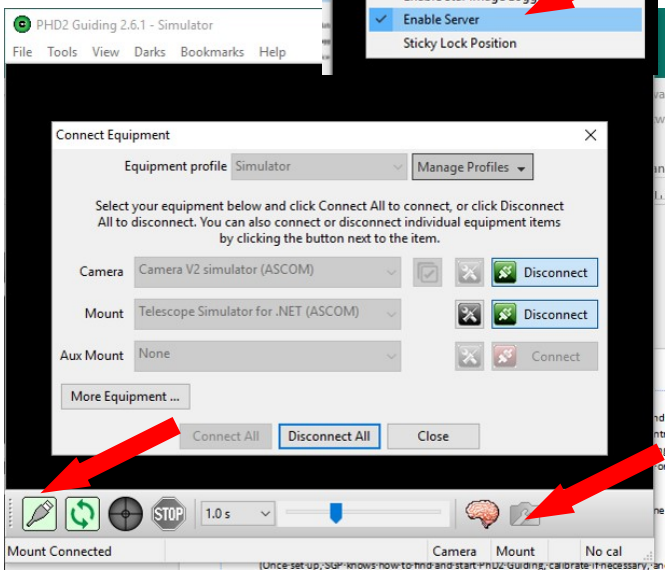
The Fine and Coarse parameters should be adjusted for your focuser. You should have set them above when you were doing the "Equipment Profile Manager." ("Fine" should be about half a CFZ, and Coarse about twice a CFZ, expressed in "focuser steps.")

Press the various buttons for "Fine" and "Coarse" movements on the "in" and "out" row. After each press, take a picture using the "Take One" button on the Frame and Focus window. Are you more in focus or out? Experiment until you bring your star or Bhat Image into focus.

If the size of the stars does not change (or the Bhat Mask spike does not move) as you experiment, check that the focuser clutch is tight, and so forth. Is your focuser actually moving when told to move? If that does not do it, under "Settings" on the Focus Control window, increase the "Coarse" step size. If the stars change too quickly (going from small to bloated in just one step), go to settings and decrease the step size. Play with it until it works for you. If the “Coarse Step” is moving too slowly, you can press the “Go To” button, type in a new position for the focuser and go directly to that position and start using the coarse and fine step buttons as needed from there.



Next, we want to get the guider going. If you have never used PhD2 Guiding, you need to spend some time with it before attempting to use it with SGP.

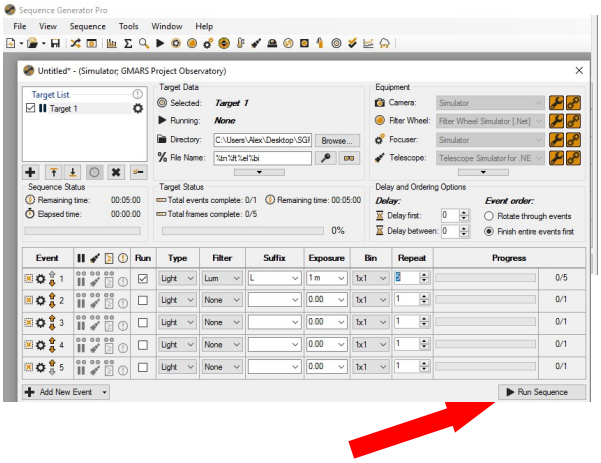


Start PhD2 Guiding by going to the Windows start menu, and clicking on the icon as you would start any other program. Check out the help menu for instructions on setup.

Configure PHD Guiding by clicking on the Tools Drop Down menu item. And open communication with SGP by clicking "Enable Server."

Connnect PHD Guiding to your equipment by clicking on its Connect Icon (The USB cable end at extreme left, bottom),

Let's check a few things.



PhD2 Guiding is open, and running in the background.

The scope is pointed at a known bright star someplace, and is focused

Your Sequencer Window is open, with one "Event" checked --a one minute luminance (or OSC)

You have specified a directory to save your shots.

The "Equipment" section has all orange "connections" icons (no gray--with the possible exception of the Focuser if you are not using a focuser.)

So move the cursor to the lower right corner of the window and **Click Run Sequence**.

The program now takes over, connects to the guider, and goes from there. You will see the following:

A message in the lower left corner of the SGP screen (not the sequencer sub-window, but SGP's larger window) saying the autoguider is starting. In that you will see what the autoguider is doing. After a bit, you will see it reporting the distance the autoguider is moving. That number should be decreasing as the autoguider moves the star where it should be. Then, when it is within the limit you specified in the Equipment profile, you will see it counting how many seconds it is there. When it meets the criteria for "settled," it will start the exposure. (In the screen capture below, the guiding and other progress information will be where the red arrow is pointing.)

The status displays now show the progress. And in sixty seconds, you should see that your exposure is downloading, and being saved. It is displayed on your screen with an automatic screen stretch. Since the event said to do this five times, it will actually repeat the exposure four more times.

Using “File/Open Image,” check your hard drive (or wherever you asked SGP to store your data). If you have the five pictures there, the SGP has done what you wanted it to do. It took five pictures, and stored them on the drive.

(Note that if it seems like things are not going correctly, you can abort the process by clicking on “Pause Sequence” button at the bottom left of the sequence window. You will get an option to quit immediately or after the shot is complete. If you choose to abort, do not (generally) run the end of sequence options, since that could unnecessarily shut your camera down and park your mount.)

Now, check the results. The last picture taken will still be on the screen. Others can be opened using “File/Open Image.” Use the Histogram/AutoStretch as needed. You are now looking for focus and guiding issues (bloated stars (Focus), streaks, stretched stars (Autoguider Problems maybe?), etc., not for exposure, noise, and such.

If you see bloating, streaking, and such problems with these exposures, DO NOT BLAME SGP. It did what it was supposed to do—collect the data and put it on the drive. The problems are with the other devices and software programs that SGP called. Consult the sections of the Help Documents in those programs if you are not getting the results you wanted, but do not go further until you resolve these issues. If you cannot focus and guide, then that must be addressed before moving on. The goal of this session is to get things connected, communicating, and doing the basics. Do not try to get the ideal exposure down, or perfect the autoguiding parameters (unless you really want to). Just

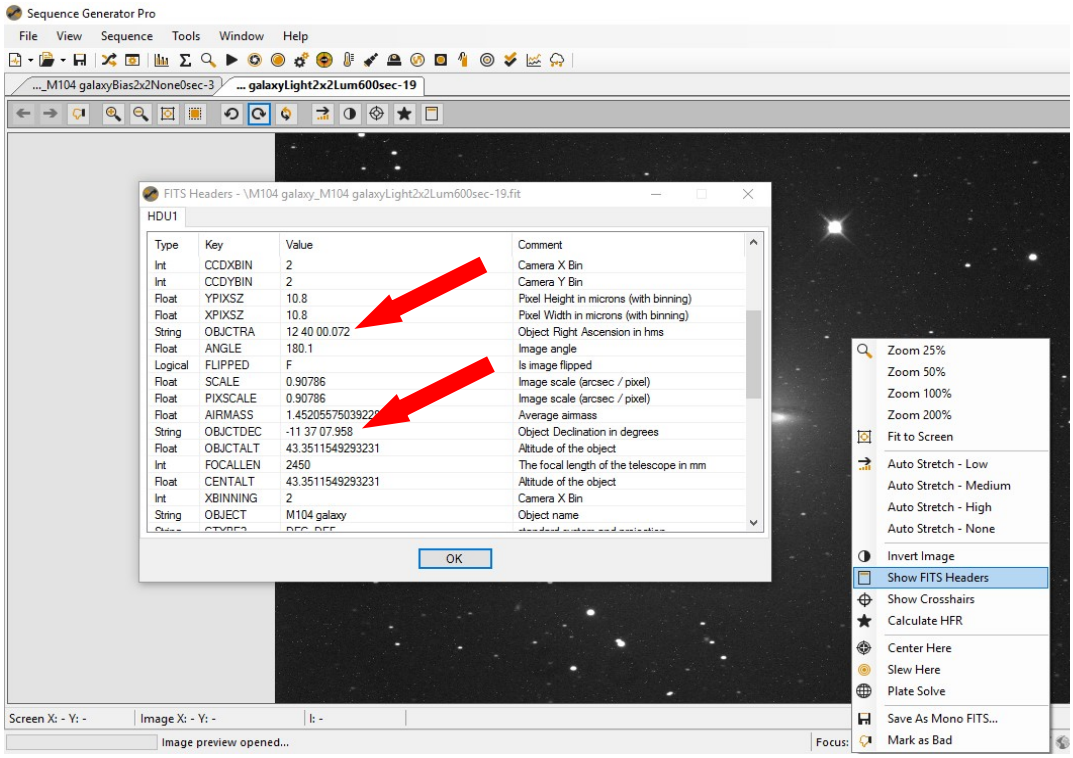
make sure you have things looking like they are working together.

If everything is good, you have had a successful night!!!

And at this point, you can use SGP to take your images for you. Simply add other lines to your Sequencer. Add the Filter, Suffix, Exposure, ISO, and Binning Information you want for the various exposures, and tell it to Run Sequence. (You may have to go under the "Sequence" Pull Down Menu and "Reset Sequence," depending on how your last run ended.) As long as you do not expect automatic focusing, or a meridian flip, or re-centering through a plate solve, you are good to go.

You can even use your mount handpaddle to head over to some interesting Messier object thirty degrees above the eastern horizon, use Frame and Focus to take a ten second exposure at your highest binning or ISO to help center the object, and run a full sequence for a few hours. (I suggest thirty degrees east (although just west a bit past meridian will do) so that you can run a few hours without worrying about a meridian flip.)

Ok, while we are here.....let's do one more check of that sample picture you took. We need to find out if your mount is synchronized and properly communicating with your software for later uses. In your first sequence, you took a picture of a known bright star high in the eastern sky. By "known bright star" I meant something recognizable with known coordinates. You have to know where you are pointing for this part of the experiment, and if you have centered that known bright star, you know where you are actually pointing. (Check the coordinates of that star in your planetarium program, your smartphone, or star atlas --or even your handpaddle (or pull out your Burnhams if you are really old school!!!). Call up one of the "known bright star" pictures you took earlier. To do this, go to File/Open Image. Maneuver to where you are storing your pictures, and select one of the images. Click on it and it appears on the window. It should be autostretched. Right Click in the middle of the image, and choose "Show FITS Header." Scroll through the information about this image, and look for the terms OBJCTDEC and OBJCTRA. Does the data match (within a few arc minutes or so) the *KNOWN* RA and Dec for that star you were going for? If it does not, you have goofed somewhere, or your mount is not synchronized to the stars. That has to be corrected if you want to do any plate solving. The biggest problem most people have with plate solving is that the "Hints" are not accurate enough. If your mount is not reporting properly where it is pointing, you will have a problem. Resolve that discrepancy as well as you can. The discrepancy is someplace in your pointing of the mount. You need a good synch so that all future gotos will put the target in (or at least very close to) the field of view.



But, that is the end of the third night. You have connected the equipment, and run a little sequence.

Night Four: Plate Solving and Pointing—A First Real Sequence

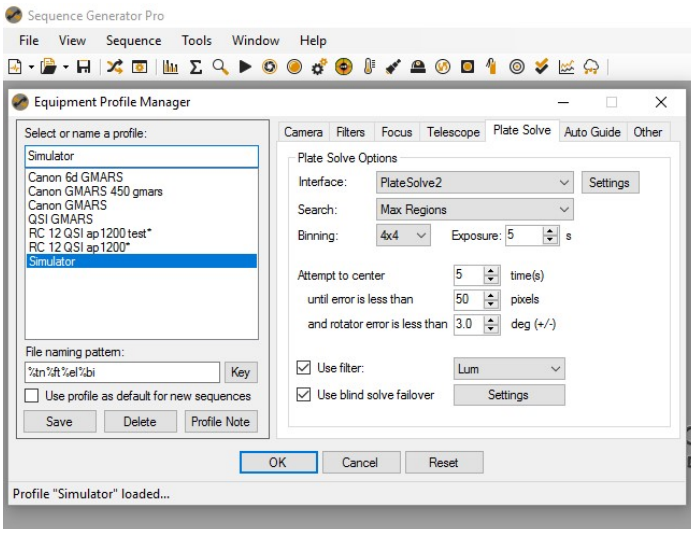
One of the main reasons for using SGP is that it can point your telescope, correct its pointing, do a meridian flip, and plan and execute mosaics for you. All this depends on the "plate solver." This is a software program, and its accompanying database, that knows where the stars are. It can analyze your picture, find its stars, and compare their positions to starfields in the database. When it finds a match, it knows where your telescope is pointed, how the camera is aligned (rotated), and how many arc seconds of sky each pixel covers.

You have your choice of several plate solvers when using SGP. I ask that you use PlateSolve2 from PlaneWave so that we are all reading from the same script. When you are finished with the tutorial, you can use what you have learned to change to one of the other plate solvers. But for now, let's just stick to one methodology.

If you have been following this tutorial, on the first night, you installed PlateSolve2's catalogues. On the second night, you configured it, by taking the defaults and telling PlateSolve where you saved the Guide Star Catalog. Hopefully, you are somewhat familiar with it, and maybe have solved a few images.

On this night, night four, you will learn how to use PlateSolve2 to aim your telescope and take a picture.

Set up your scope so that it is ready to take pictures. It should be just as you left it last night, powered up, polar aligned, balanced, synched and all that. It should be pointed to a known, bright star high in the sky. Tonight, let us try a star just west of the meridian. (But again, any bright, known star is good. We pick a star west of meridian to avoid the possibility of a meridian flip.)



Let's make sure we are ready. On the main pull down menu, go to Tools/Equipment Profile Manager, and **click on Plate Solve tab**. Click on the name of your equipment profile. Take the defaults for Search, and Binning. For our purposes, tell it to attempt to center 5 times to within 50 pixels, (and 3 degrees rotation if you have a rotator), using your Luminance filter. Check the "Use Filter" box, and the blind solve failover. Make sure the Settings for failover show the local ANSVR software (or remote if you have internet). Click OK and save.

And let's make sure the plate solver knows the scale of your camera. On the Tools/Equipment Profile Manager, and **click on Camera tab**. Make sure you have calculated as well as you can the plate scale (from http://starizona.com/acb/ccd/calc_pixel.aspx or whatever other source you have). The program asks you to specify the 1x1 (unbinned) scale—not a binned scale. The program will recalculate your scale as you bin. Save the information.

Connect all your devices, just as you did last night by clicking on the red icons.

Let's RERUN the experiment you did at the end of last night, this time with a single star right known bright star, but **west** of zenith, and just past zenith, instead of east. Start a new sequence, and take a small series of one minute exposures. Call up one of those images, right click on it, and Show Fits Header, and compare its RA and DEC with the known location of your target star. It should match pretty closely.

Now, **Run a Plate Solve.** Right Click again on that same image, and select "Plate Solve." Up pops the Plate Solve window. Under" Object" type in the name of your known star (Vega, Arcturus, or whatever). Note the RA and DEC hints. They should be the OBJCTRA and OBJCTDEC data from the FITS Header. The Angle will be the one you provided when

setting up the profile (but it does not usually matter). The Scale will be the one you provided in the profile *adjusted by SGP automatically as needed if you binned the image*. Ready? **Click Solve**.

PlateSolve2 starts up and goes through some gyrations, and reports where it thinks the image is in the sky. If it solves, you got a winner. Note that it also tells you the orientation (rotation) of the camera, and the image scale. Use this information to correct the information you have in the equipment profile if needed. Use this information to help synch your rotator if you are using one. But most importantly celebrate that, at least for now, you do not have to slog through the next few paragraphs. (Read them anyway--you may need them some day.)

If your image did not solve with PlateSolve2.....Here are some suggestions:

…..If PlateSolve2 does not solve in the first dozen or two iterations, it may well not be able to solve at all. But, until you get familiar with the program, keep it running for many more iterations than that. It may still work.

...Sometimes you need to "blind solve." In your Equipment Profile, you specified to use ANSVR if PlateSolve2 failed. So, if you get a message that PlateSolve2 failed, your computer should be going on to the blind solve automatically. It will take longer, but usually works. You really want PlateSolve2 working, so if you go to blind solve, you still need to remedy the original problem. Use the information from the blind solve to help you fix PlateSolve2 hints. Get PlateSolve2 to work before moving on.

...Most often the "hint" information is incorrect. Hint information is the target *location* and image *scale*. You should have checked for this before you started the plate solve if you were following this tutorial. Incorrect *location* hint information comes from not having the mount properly synched to the sky before the image was taken. It could come from improper settings in the handpaddle/mount control. It could be poor communication from the mount to the computer. It could be poor pointing in the scope, or lack of a good synch. In rare instances it could be a misunderstanding between your mount and catalogue (They are using a different “epoch” to report their coordinates.). Whatever it is should be explored and remedied. Incorrect *scale* hint information comes from miscalculating the field of view, or pixel coverage (scale). When you entered the scale in the equipment profile, you should enter the scale of ONE (unbinned) pixel. When you bin, SGP will calculate what the actual pixel scale should be. The "Rotation" parameter is not so critical. The plate solver can pretty much figure how the camera is rotated once it locates the area.

...Sometimes the plate solver has a problem solving when there is a particularly bright star in the image or a lot of nebulosity, or the image is dominated by lots of stars (as in a closeup of a large Glob). And that bright star image is exactly the kind of image we are working with. Move your scope a few degrees, take another picture without that big bright star, call it up *from the hard drive* (don’t use the image SGP is displaying on the screen as the last picture taken), and plate solve it. Maybe that big bright star is the only problem and it solves correctly this time.

...Sometimes the plate solver gets confused by areas of nebulosity. Try a different area for your first solve.

...Sometimes the plate solver does not find enough stars. You can increase exposure in the image (although if your original exposure was 60 seconds this is unlikely to be a problem--Plate Solve exposures of more than a few seconds are generally unnecessary). Or, you can make sure you are using both catalogs from the PlateSolve2 download site. It takes up more disk space, but helps in these situations, and particularly with long focal length telescopes.

At any rate, do what you need to get PlateSolve2 working such that it reports where you are pointing in the sky, and the proper image scale. If you do not get a happy solution, try with another image, or re-shoot the image with more or less exposure. But, you need to get Plate Solving working. If you go on without it, you will not get full benefit of the SGP program.

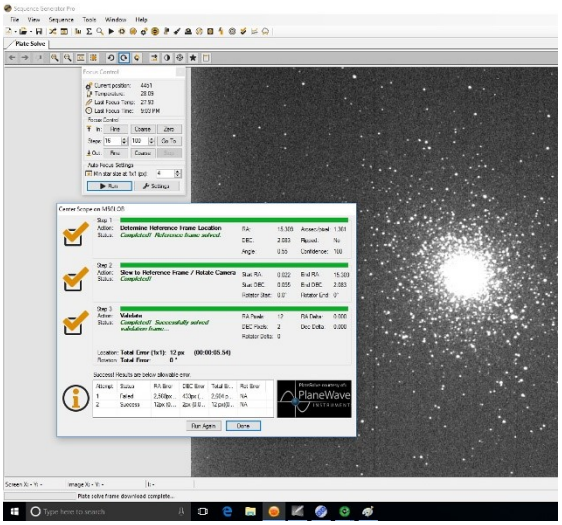
Once you do get a good plate solution, look at your results.

Notice the Rotation of your image. The Rotation does not really matter to your imaging. Some imagers prefer a rotation of "360," i.e., north to the top, but, really, there is no north in space. Some prefer whatever gets them a pretty composition. I like my diffraction spikes either north-south-east-west or at 45 degree angles….not in between. In some cases (such as when used with a planetarium program to plan where your guide star is in relation to your object) it does matter.

The scale reported from the plate solve is the actual plate scale, regardless of what Starizona's website or anybody else reports. Fact is, focal lengths and scales of telescopes shift with focusing, temperature, with manufacturing, focal reducers, flatteners, spacing of such things, and obviously with binning. You want to take the solved Plate Scale and put that information back into your Equipment Profile/Camera. But remember, SGP wants to know the plate scale of 1x1 binning, and your image may have a plate scale based on 2x2 or otherwise.

With the power of Plate Solving at our disposal, we are now going to nudge the scope around a bit.

(For the next few exercises, your autoguider should not be guiding.) Open the Frame and Focus (by pressing the Sunburst Icon). Take a ten second picture, by adjusting the exposure and pressing "Take One."



Run a "Center Here" If everything is as it should be, we should have a few stars in the picture. Pick a one that is a far from the center and RIGHT Click on it. From the Pull down Menu, choose "Center Here." The centering process will take over, taking a picture, comparing it with where it should be, moving the mount, taking another picture to see if it moved to the right place, maybe doing it again, and again. Then it reports "Success." Study what just happened. This is SGP's plate solve and centering at work. Your selected bright star should now be in the center of your picture. (Use Crosshairs to check.)

Play with it yourself for a while. You are the Monarch of the Mount and can move that star anywhere in the frame!!!!! (or completely out of it if you want to).

It is important to get this process right. It is the basis of much of the automation, target finding, meridian flips, and so forth that give SGP its power. If it is not working, session automation cannot be complete.

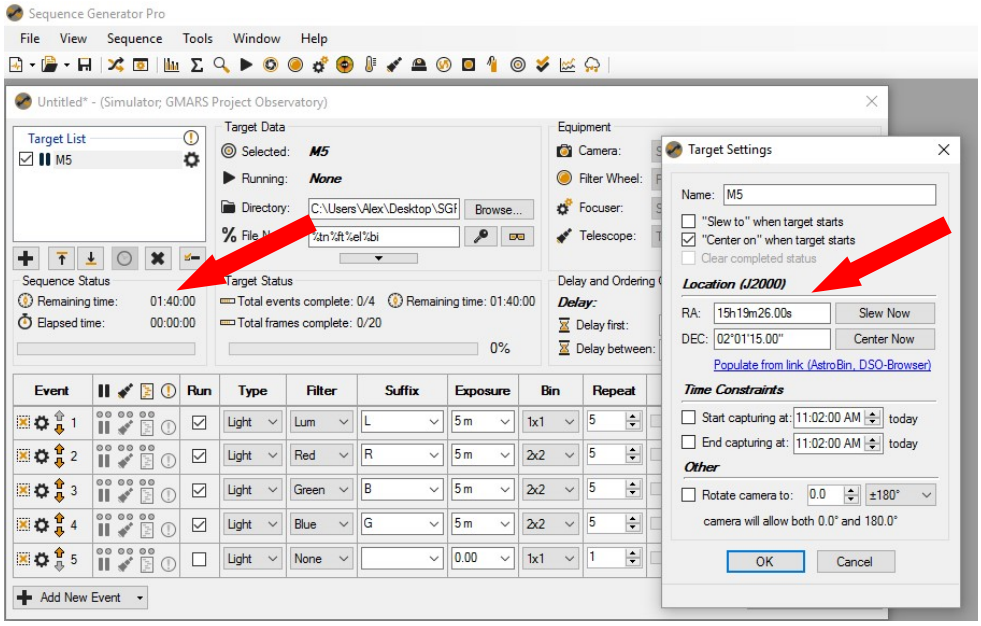
If this exercise is not working, determine whether the problem is with plate solving (you are not getting plate solve solutions) or with mount movement (no matter how many tries, you do not close the gap and get your mount to point accurately). If it is the former, go back and re-do what you did when you first tried to plate solve, and get the plate solve working. If it is the latter, do some inspecting of the mount and equipment setup. Is there too much backlash? Is your mirror flopping or some cable hanging up?

One more thing to learn before we call it a night.....Setting a target.

(Obviously your equipment is still set up, focused, and so forth. If not, make it so!!!)

On the Sequence window, in the upper left hand corner, is a "Target List." Click on the little gray "cog" icon. The Target Settings window pops up. Pick some nice bright Messier Object (or something recognizable on your wish list) just a few degrees past the meridian. Enter its name and coordinates in the appropriate boxes. Note that SGP is multi-lingual, and will accept coordinates in at least three formats. So, 29:30:00, 29.5, and 29d:30m:00s say the same thing and can be entered into the coordinate boxes. Under the "Name" entry box is a check box for "Center On" when tar-

get starts. CHECK it, but UN-check all the rest for now. Tell the input window "OK." (We selected a target just west of the meridian so that we can avoid a meridian flip after a few hours. You can, of course, aim anywhere else in the sky you like, but for now, to avoid a meridian flip, start just west of the meridian, or someplace about 30 or 40 degrees above the eastern horizon. This gives you time for a full three hour run before a meridian flip.)



You are looking at the main Sequence window now. You should enter the Directory information (where you want your images stored), take the default on the file name, and Event Order (for now). Connect your equipment as needed by pressing the connect buttons to change them from gray to orange. You have done all this before.

In the Event lines, go ahead and order up a series of exposures, checking "Run" for every line you are using, and setting Type, Filter, Suffix, Exposure, Binning, ISO, and Repeat as you see fit and appropriate for your equipment. You have done this before also.

As you set up your events, note that under "Sequence Status" (under the Target list on left side of Main Sequence window) the times change to tell you approximately how long your sequence will take. Don't go for more than about three hours in this run (to avoid a meridian flip if you start at say 35 degrees above the eastern horizon, or to avoid the western muck if you start at the meridian).

Ready?

Start a Sequence Click Run, and go take a nap. (Knowing you, you will probably stay up and watch as your little robot goes through its little imaging session. But, really, you could go take a little nap if you wanted.)

What you will see is the scope centering on the target object you picked, going through a series of plate solves and corrections to do so, then starting the autoguider, waiting for it to settle, picking the filter, setting the binning, ISO, and other things needed to take the image, downloading and displaying that image, and then proceeding to take the rest of your series of images and save them to disk.

If you are not napping, watch your images occasionally. See how they come down. Use the Histogram function like you did earlier to “Autostretch” the data. (This does not change the actual image—just how it is displayed.) Switch over to PhD Guiding, and watch your graph if you like. It’s fun. (If your Phd Guiding graph looks real shaky, increase the scale to +/- 16 pixels. It won’t change a thing about the bad guiding, but the graph will look smoother.)

If things go real wrong, you can Pause Sequence, (see lower right hand corner of sequencer window) and restart the whole thing.

Assuming you are successful, you know how to Plate Solve and Point, and you have started a little imaging run--which is what you were after for the evening.

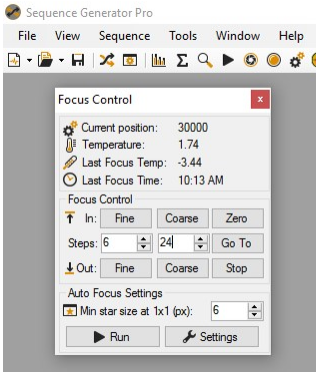
Night Five: Autofocus

Autofocus deserves a night of its own.

The developers have made great strides in the autofocus program, both simplifying it and making it much more robust in a range of circumstances. The system was always pretty good with a nice refractor in an open cluster, but struggled with some nebulosity, or longer focal length, and particularly obstructed scopes like SCT's and RC's. Those days seem to be gone, though.

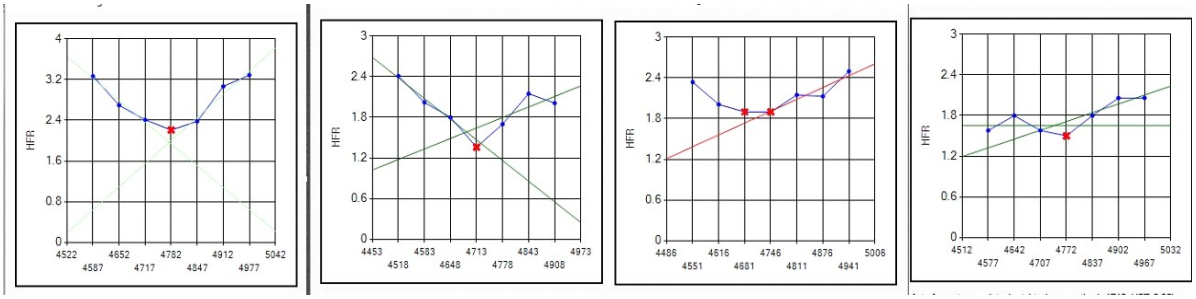
You can possibly get by without using Autofocus in SGP. Simply focus with whatever method is comfortable. One such method is described under night three. Using Frame and Focus and the focuser control tool (or however you move your focuser if you do not have a motorized focuser), simply move in and out, taking a series of pictures as you watch the stars get smaller or bigger. Your eyeball (and especially your eyeball with a Bhat mask) should do a good job of showing when the star is smallest (in focus) but if you want to add a bit of science and statistics to it, right click on the image and choose "Calculate HFR." You will see on the display just how big your stars are. If you are going to go without autofocus, you will want to stop your sequences occasionally to adjust for filter differences, or temperature changes. To do so, take advantage of the Focus reminder function. For how to do this, see “Help/Help File/Focusing/ Frame and Focus/Focus Reminders.”

To start autofocus, you will need to get pretty close to focus, not perfect, but close. Use a manual focus as described in night three, and repeated in the last paragraph. Incidentally, once you find where your focuse is positioned when at focus, mark it somehow (a magic marker on the tube (or a bit of white paint on a black focuser tube) will work). It does not change substantially from night to night, unless you change your camera and attachments.



Assuming you are using Autofocus, you must set your parameters correctly. Hopefully, you read Understanding AutoFocus (at Help/Content/Focusing/Autofocus/Understanding Auto Focus), and followed their methodology. I really cannot do a better job of explaining the various ways to set your parameters than Jared and Ken did in their description. I would remind you, for now, to "disable smart focus" in the autofocus settings if you have an obstructed scope. But if you have a refractor, you should be good to go. I also recommend you use nine "Data Points" to focus at first. Later you can cut that to seven or even five to speed things up. But for now, leave it at nine. (If your extreme data points give really strange readings, cut down to seven or five data points.)

Do a Focusing Run Open the Focus tool, (intermeshed cogs icon in tool bar) and press "Run." The software moves your focuser out four steps (if you told it to take nine data points (four outside, the middle, and four inside makes nine altogether)), takes a picture, displays it, marking the stars it is using, and showing their HFR's. It also shows a graph of the average HFR of all stars it is using. Then it steps in one step and does the same. And three more times until it is back where it started. Then it proceeds to step out the other side, doing the same thing. As it does so, you can see the graph building. Hopefully it takes the shape of a "V." This indicates that it was out of focus (high HFR), progressively more in focus (the HFR decreases), reaches a minimum (where it is focused) and then gets increasingly out of focus as it proceeds to move along. In fact the "V" is often a Gull Wing, with rather steep slopes in the middle and feathering off to the sides. Sometimes it is a "J" or a backwards "J"



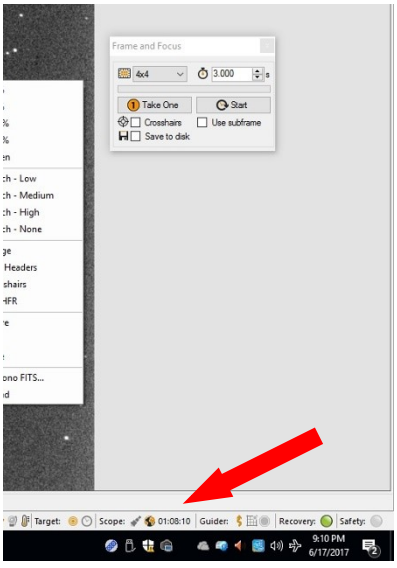
because it did not start out right *at the* best focus and one leg is longer than the other. Sometimes the sides are not straightish lines, but rather jagged. It is still working (probably), but needs to be monitored. Provided are four focusing graphs. Note the pretty “V” (or at least a shallow “U”) at the far left. That is how it is supposed to look—but all of these worked.

If you do not get a nice clean “V” or “U,” you may run it again. This time you will notice that the middle of the graph is in the position of best focus from the last run, and it should be more of a "V" than a "J." Note that it will never be perfect. Seeing and such just get in the way.

If you notice that the downward graph never turns back up, or an upward graph never turns down you were not close enough to focus before you started the run. You ran out of data points before you could reach focus. If your focuser is not already at the position that gave you the lowest point move it there, and try again. Smart Focus is made to prevent this. If it sees that it has gone through its specified travel range, and still has not changed direction, it will add data points and keep trying. The latest Help manual advice says to disable smart focus for obstructed scopes (newts, SCTs, and RCs) or do some serious tuning, which is a bit more than we can do with this tutorial.

Run it several more times. You should get a V (or U or Gull Wing) like it every time once you get it set up. But you may notice that the actual focuser position value may be changing as it does. There is a bit of randomness involved. Seeing is one obvious problem. Make your exposures at least five seconds long to combat this scintillation. Wind, clouds, and the vagaries of mount vibration and such can affect things. Many scopes contract as they get colder during the night, and particularly in the first part of an evening, when you are liable to be watching focusing operations. This can cause a shift of focuser position progressively outward. Moreover, optical theory says that there is no one exact focal point. A "Critical Focus Zone" can be determined for every focal ratio within which focus is essentially equal. It is not a point, but a range of distances. If your point of best focus from one focusing run to another is within this Critical Focus Zone, then you are in fact focused, even though the number is changing. So, don't be obsessive about having exactly the same focusing position on every run. Just make sure you are getting the smallest stars you can practically achieve.

Getting "V's" on your autofocus runs? Then it is time to put them to work.



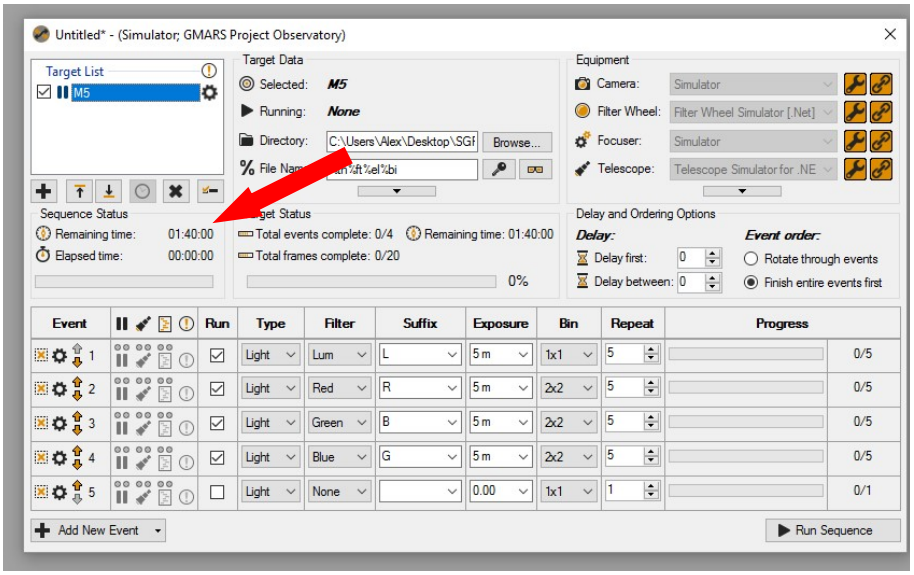
Start by going back to your Equipment Profile. (Tools/Equipment Profile Manage/ Focus). Put an "X' in "Use Autofocus," and click on "Set." In the Autofocus Options, choose how often you want to have Autofocus run. You probably want it to run "before sequence start." I like to run mine whenever I change filters, which is about every hour. This not only makes up for any differences in filters, but adjusts for any temperature change over the last hour. If you have a one-shot color camera, and do not change filters, you may want to refocus every tenth frame, or every hour. Save your changes and exit.

Let's start a new sequence. (We want to start a new sequence because we have made changes to the Equipment Profile. To be sure the sequence recognizes the changes, we need to start with a fresh sequence.) Go to File/New Sequence. Start your equipment (change the gray equipment connection icons to orange). Build a new sequence as you did in previous nights. Pick a target at least three or four hours before the meridian, or one just past the meridian (so we can avoid meridian flips), and complete the target information (Target List/Cog icon). Then complete various event lines to get your exposures.

You can tell how much time you have until the scope crosses the meridian by looking at the bottom line of the SGP window.

After the Scope: you will see a "globe" icon and a time indication. That is the number of hours and minutes until your

scope gets to the meridian. If you are imaging in the east, and want to avoid the meridian flip, make sure your sequence is shorter than that time.



You can get a rough estimate of how long your sequence will take by looking just below the Target List in the Sequence window. Beware that, until you have configured download times for your camera and a few other pieces of data, these times will be somewhat shorter that actual time in a sequence.

In the Sequence window itself you will notice (at the right just above the event lines,) the Event Order. For now, click on the "Finish Events First." We will explain why on night seven.

Check things over and click "Run Sequence." And off it goes, while you watch to see that it goes to the target, centers it with iterations of plate solving and moving, does its autofocus thing, starts the autoguider, and starts taking pictures. When it is finished, it shuts down.

Good Job for night five.

Night Six: Meridian Flips

If you have a fork mounted SCT, or a German Equatorial Mount that can rotate all the way around without banging into a pier or itself, you may want to ignore this section. But, quite a few imagers need to stop their imaging, bring the telescope to the other side of the mount, and re-point it about the time the target object crosses the highest point of the sky. This is called a Meridian Flip. At this point, the image is turned upside down, the guide commands have to be reversed, the guide star re-set, and a number of other nasty things. Worse yet, except for the finest of mounts and OTA's, with the most careful of polar alignments and pointing models, the telescope rarely is pointing precisely where it should be after the flip. SGP can fix all that while you snore.

Mastering the Meridian flip means mastering mount idiosyncrasies as well as SGP.

Travel Limits: You should experiment with your mount to know just how far past the meridian it can go. If you can set your "safety" limits so that the mount can go an hour or so (fifteen degrees) past the meridian, go ahead and do so. If you have a hard limit at the meridian itself, you need to know that.

It is critical to have good polar alignment, a good pointing model, and orthogonality (The right ascension axis at right angles to the dec axis). To check this, center on a star on one side, but near, the meridian. Do a meridian flip and see that the star is centered. It should at least be within the field. If it is not, you need to do some mount work. (Sorry, that is beyond the scope of this tutorial.)

You need to test your mount by doing a meridian flip.

If your mount handpaddle gives you the option of a “Meridian Flip,” execute one manually.

If you do not have a "Meridian Flip" command, You may have to stop your mount, execute a meridian flip by hand (using the buttons on your controller to slew the mount), and, after allowing sufficient time for the star to cross the meridian, do a "goto." Alternatively, pick two known stars high in the sky, one east and one west of the meridian. Alternate "gotos" to these two stars. If your mount flips completely (not just moves past the meridian to get to the other star), and can still point correctly to both, your mount should have no problem flipping. If it does not, you will be lucky if the Plate Solver will have the correct "Hint" data. This will mean you won't be able to continue a long sequence.

Be aware that a meridian flip depends also on how stable your mount is in terms of gear slop, mirror flop, focuser droop, and all sorts of things like that. Your equipment is getting turned upside down and rotated around. Things shift sometimes. Do what you need so that your mount, OTA, focuser, and all will consistently flip and point fairly well afterward. It need not be perfect, but the closer the better. And remember, if you cannot get it to work reliably WITHOUT SGP, then it won't work WITH SGP.

Get the cables organized so that they cannot tangle or foul when moving the crazy ways a GEM can drag them. In other words, there should be just enough slack where things move, and none elsewhere. Excess slack tangles. But you must have enough that the mount can move freely.

Since a run including a meridian flip can last all night, arrange your computer so that it will run all night. Some computers go to sleep, or even shut down, if there is no keyboard activity in a certain time. SGP is built so that your computer will not go to sleep while running SGP. But you can also change your computers power management parameters to make sure the system will not go to sleep in the middle of a run.

Next, make sure SGP is set to do a meridian flip. Under the Tools/Equipment Profile/Telescope, you should see your telescope already selected. For now, UNcheck the boxes for “Park Telescope when Sequence Completes,” and “Allow External Control.” Skip the “Use Meridian Flip” box for now, and notice the "Mount Settling Time." I would recom-

mend giving this three or four seconds, although your mount may not need to settle after a move. Leave the Nudge at High, and uncheck the Reverse Boxes, unless you know better for your mount.

CHECK Use Auto Meridian Flip . and press the "Set" Button. This brings up the Flip Options. UNcheck all the boxes for now, except CHECK "Auto Center After Meridian Flip."

We must do a little thinking about the number of "Degrees Past Meridian" to flip. For most of us with a GEM, we can in fact go past the meridian by an hour or more. But some mounts have a hard stop at the meridian, and cannot be set to go past this point. SGP checks after each exposure to see if the time for a meridian flip has passed. If it has, it executes the flip. If it has not, it starts the next exposure. The problem is that the next exposure may take more time than the mount has before it hits the hard stop. If this happens, the mount stops, autoguiding will not correct for the loss, and the exposure will be ruined. In addition, your pointing could be upset for the next shot. But you can set the parameters to avoid this problem:

> If your mount can safely go past the meridian, set the safety limits (on the mount itself, not the SGP software) to go an hour or whatever it can safely go past the meridian. And set the "Degrees Past Meridian Flip" in the SGP Meridian Flip Options to "0." When you get proficient, and for some sequences, you may want to change, but for now, 0 will work fine.
>
> If your mount has a hard stop at the meridian, estimate what your longest exposure will be while using the system. For most LRGB imaging, this should be about ten minutes. But for Narrow Band, the longest exposure could be twenty or more minutes. Next, figure how many degrees the scope will have moved in that time. And set your "Degrees Past Meridian to Flip" parameter to MINUS that many degrees plus a small fudge factor. (A scope moves fifteen degrees an hour. Twenty minutes (for example) is one third of 60 (minutes in an hour). So, in a twenty minute exposure, the scope would move one third of fifteen degrees. So, for a twenty minute exposure, set the parameter at -5 degrees plus -1 degree for safety. Set it at MINUS 6.) Note, of course, that a mount that will not allow you to go past the meridian may not let you point ahead of the meridian from the other side. You may have to make some compromises.

Press, OK, and close out the equipment profile, saving your work.

Pick out a target just east of the meridian. As a learning exercise, pick something fairly close to the meridian. You are, after all, testing to see if your SGP and system can pull off a meridian flip. The longer you have to wait for the object to get to the meridian and past, the longer it is before you know you have it right. The further your object is away from the meridian on the east side, the longer it will be before the flip!!! Most planetarium programs will tell you how long before your object will transit. Pick something that is fifteen minutes (of time, not RA) PLUS the time of three or four exposures or so away from its transit time. (More if your mount requires a flip before actual transit time--i.e., your "Degrees Past Meridian to Flip" parameter you set in the last step is a MINUS number.) This will give time for the focusing routine, centering, plate solving, and all that, and will assure that you have exposures on both sides of the meridian during your sequence.

Start a new sequence from scratch. Using what you learned last night, enter the coordinates into the Target settings window. Make sure your sequence is at least twice as long as the time it will take to approach the meridian. (This assures you will have exposures on both sides of the meridian.) (And, by the way---you can pick a pretty object, put in proper exposure times, and actually use this as an imaging run. If the flip works, great--you are on your way to an imaging run.) Remember the notes from last night about the Globe icon at the bottom that tells you how long before a meridian passage, and the estimated time to execute your exposure.

When you are ready, check things out to make sure you have the sequence set up right, and tell it to "Run Sequence."

Monitor it for a bit to see it is doing what it is supposed to do. Notice down in the lower right corner of the SGP screen, near the Globe Icon how the time is counting down. (That is the time of meridian transit. The actual time of the flip will depend on whether the exposure is done, and other parameters that you set for the flip.)

When Flip time arrives, you will see SGP finish the exposure, then take start the flip procedure. The flip procedure consists of taking a picture, plate solving it to determine the present position, slewing the scope, and taking another picture to plate solve to determine position. It then corrects and repeats the procedure until it either gets where it is supposed to be (in accordance with parameters you set in Tools/Equipment Profile manager/Plate Solve Options) or cannot get there. Assuming it got where it should be, it continues with the sequence. It then resets the autoguider, and waits for it to settle, and restarts the imaging.

And you? You are slowly realizing that this SGP thing makes it so you can sleep through the whole night now. You sleep while it captures the images for you.

Or you can dust off that Dob, and rediscover the joys of astronomy!

Or maybe it didn't successfully flip. (So much for the “joys of astronomy.”)

If it did not flip properly, the error message *might* show that the mount could not correct itself within the number of tries you specified. Was the mount changing position between the exposures, but simply could not get close enough in the number of tries you specified? In other words, the plate solves are fine, but the mount is not moving far enough go back (to Control Panel/Telescope/Use Meridian Flip--Set) and specify a greater number of tries or greater number of pixels. (And look into what makes your mount and tube so poopy that the system cannot correct itself in five tries or so.) If the plate solver is working fine, but the mount is not moving at all (or erratically) between exposures, look to see how your mount is deficient, but do not change the number of tries or such.

A failed meridian flip could also be caused by the failure of the autoguider to reselect a new guide star (your imaging field has been turned upside down, and your guider no longer points to the place in space where you saw guide stars on the east side of the meridian). You may need longer exposures. Or you may need to slightly shift the image target area so that the guider target are shifts to where it can pick up a star.

More likely, a failed flip shows a failed Plate Solve. Well, we know the plate solver is working for this combination of optics and camera. We have already used it several times tonight. (And it continues to work even when a meridian flip actually *FLIPS* the image.) Remember, the developers at SGP have your back..... You can select a backup "Blind" solver for when Pinpoint fails. You did it before on night four. ASVNR will attempt to solve and get you back on track.

A failed meridian flip is nearly always something mechanical with the mount, the pointing model, or some other physical thing. GIGO: Garbage in, Garbage Out. The plate solver got the coordinates for the hint from your mount. But your mount is probably not really pointing where it says it is. *The Number One failure of meridian flips is that, after a flip, the mount is simply not close enough to the coordinates it is reporting (where it thinks it is).* This means the solver hint will be bogus and the sequence will quit. Unfortunately, this is not an unusual occurrence for amateurs like you and me, with amateur equipment, on a rough setup.

Review the information at the beginning of this tutorial section about what it takes to make your mount work right in a flip. An automated meridian flip is one of the great things about SGP, but the program cannot do a flip if the equipment won't. Really, get your equipment working properly and polar aligned correctly so that it knows where it is pointing. Then Plate Solving will work. Your sequence will continue after a flip. And you will sleep all night.

Night Seven: Your First Full Sequence

Tonight, we will build and shoot a sequence with five Events. By the end of the evening, SGP will have collected a number of images for us, both lights and darks, while we sat around doing nothing. (Except worrying if it would actually do it!!!)

Before going out tonight, pick a bright star or deep space object *someplace high in the eastern sky* when you will be starting out. Get its RA and Dec coordinates from your favorite planetarium program or catalog. Make it something bright enough to show, easy to recognize, and so forth. This time there is something special about the location of the object. By picking an object east of the meridian, we force a meridian flip in the middle of the sequence. If you have a fork mounted SCT or other mount that does not flip, aim at whatever object you like.....

Set the entire rig up for imaging, including polar alignment, power on, balance, synch, and all.

Start PHD Guiding.

Start SGP.

Go to your Tools/Equipment Profile Manager . Earlier, we did not check some of the boxes because we did not want "End of Sequence" actions to take place while we were learning. But tonight is our final exam, and we want to actually shut the system down after it is finished.

...Under Camera (if you have a cooler), CHECK, "Warm Up on Sequence Complete"

...Under Telescope, CHECK "Park (or stop Tracking--your choice) When Sequence Complete." Use "Auto Meridian Flip" should be checked and set from last night.

....Under Autoguiding, CHECK "Stop Autoguiding When Sequence Complete."

Your other necessary settings are already where they should be if you have been following this tutorial.

Start a new sequence so that all the changes you just put in will take place.

On the Sequence Window, start and connect all your devices as you have on previous nights.

Click on the target setting window icon (the little gear next to the target name).

Under Settings, enter the Name of the object you have chosen.

Enter the RA and Dec Coordinates for the object you have chosen for this lesson.

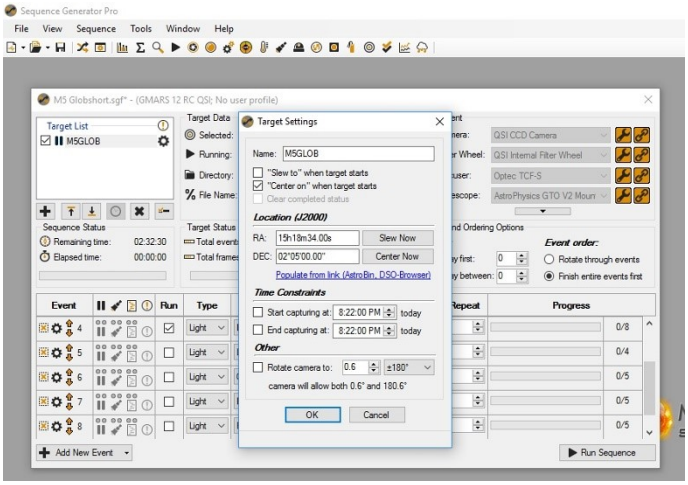
CHECK "Center On" when Target Starts.

UNcheck "Slew To" when target starts.

UNcheck both Time Constraints boxes

If you have a rotator, and know where you want it set, click the box under "Other, On target start, rotate to:" and set the rotation.

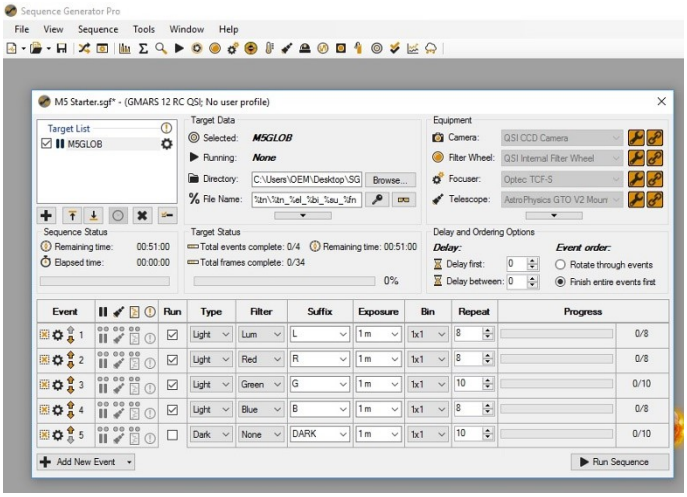
Click OK and return to the main Sequence Page. Under "Target Data," (center of top of window), you will see the Directory and File Name information. Using the Browse button, specify where you want to keep your images. I would suggest that you would want to make a new folder under the name of the object you are shooting and store tonight's



images there. Take the defaults for the File Name for now.

Turn to the bottom half of the Sequence window. You will see a table with ten columns and five rows. For now, we are going to ignore some and focus on others.

Event: Largely ignored, until we learn to use them. The Event column icons will all be blacked out (except that little up arrow in event 1, which is gray). If you are manually focusing on each new event, you may want to put a reminder to do so.



The second column, which sets up advanced options for the event, will be all grayed for us.

The last column, Progress, will come to life when we start the sequence.

For a cooled CCD taking a series of LRGB and a set of matching darks, do the following:

The Run Column should have checkmarks in the five boxes. This indicates that on this run, we will execute all of these events.

For Type, under event 1 through 4, enter "Light" and under event 5, enter "Dark."

Under "Filter" pull down the selector and specify your filter names:L, R, G, or B.

Under Suffix, give the image a name, usually related to the name of the filter. (This may autofill.)

Under Exposure, enter the exposure in seconds or minutes you want for this run. This is an actual imaging run, so enter what you feel is the ideal exposure.

Specify the desired Binning in the next column. (Keep them the same for this learning experience (since you will be taking only one set of darks.)

And finally, tell how many exposures you want of each filter.

(Note that if you have a OSC or DSLR camera, you will have a slightly different configuration, will not be going for different filters in your events, and may be setting the ISO. You may have only two events—Lights and Darks.)

The program needs several more pieces of information. Look at the right side, middle, for "Delay and Ordering" Options.

For now, set both delays to 0.

For Event Order, decide whether you want to "rotate through the events" (This takes images in the order of "LRGBDark LRGBDark LRGBDark LRGBDark LRGBDark" this is useful if you have iffy weather and want to be sure to get at least some of each type of exposure before the clouds ruin the evening. But it is a pain if you want to refocus on filter change.) or "Finish Entire Events First" (This takes “LLLLL RRRRR GGGGG BBBBB

DarkDarkDarkDarkDark," and moves a bit faster, perhaps, since filters do not need to change, etc.) For our exercise, select "Finish Events First."

Let's check that we are ready to go.

Did you configure the Equipment Profile on the second and subsequent nights as suggested? If so, when you started a "New Sequence," the information from the profile was transferred here.

Click on the Target List, Target Settings Icon and see that the coordinates are entered properly. "Center On When Target Starts" should be checked, but no other boxes (unless you are using a rotator). OK

Back on the Sequencer window:

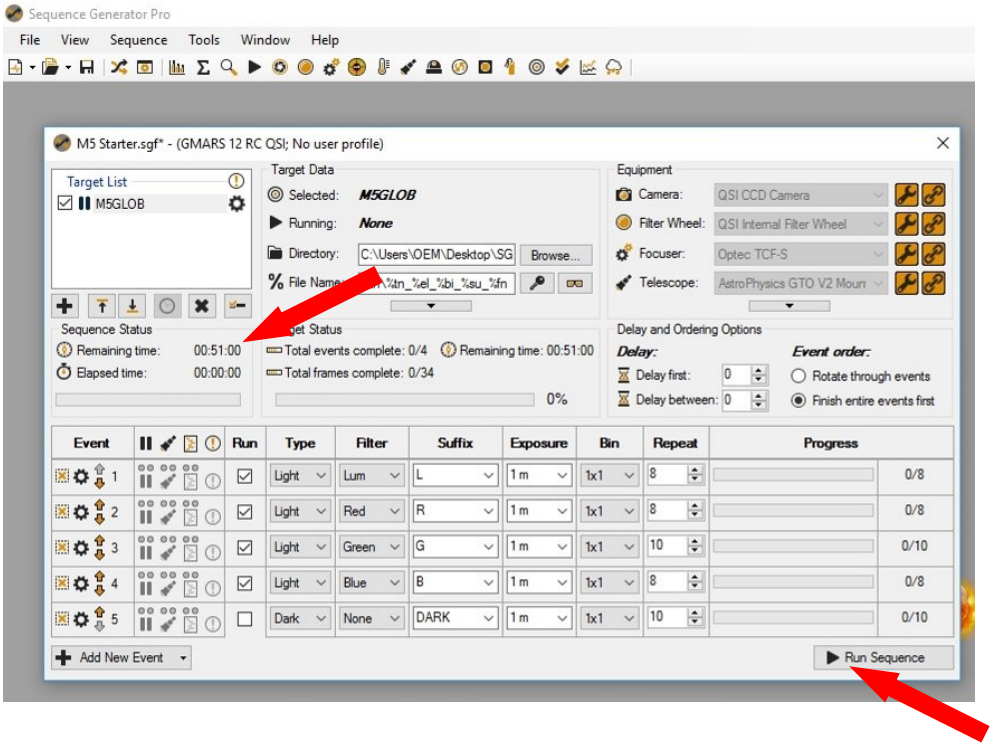
Your target is named,

Your Directory and File Name information is entered,

The Equipment icons are all showing orange (meaning they are connected)

The delay boxes are showing 0, and you have selected the event order (Finish Events First)

In the table of the sequences, you have checked the events you want run (all five—or two for a OSC or DSLR), and specified the time and filters for all.



Ready?

Almost…..First make sure you are not in the middle of something else. Under the main menu, pull down "Sequence" and execute "Reset Sequence Progress." This cancels out any unfinished sequences you may have been running. If something goes wrong tonight, and your run fails, come back and do this again before restarting a new run. You may also want to stop PHD Guiding if something goes wrong.

Then, press "Run Sequence," in the lower right corner.

Monitor the progress. Notice that the sequence window (under the Target List) tells you about how long have left in the sequence, and how long it has been running. Note that the time remaining does not take into account focusing, plate solving, slewing, and downloading----so the sequence will take longer than indicated. (Once you have some experience you can change your equipment profile, give time estimates for these operations, and the "Remaining Time"

will be more accurate.)

If it works, you should see a series of exposures come down from the camera. These will include Image Lights, Darks, and a number of focusing, plate solving, and other images. You will see comments as to how things are progressing. When the sequence is complete, go to the Main Pull Down Menu for “File,” and "Open Image." Navigate to the folder you had specified for your information. You should see two folders, Lights, and Darks. The lights will have your five exposures of each of four filters, and your Dark folder will hold the darks. If you are using a One Shot Color Camera, the Lights will have five images, and the darks, the other five. (Assuming you took five of each.)

That was the main goal for the night, and for the week. You have taken a set of pictures, had the camera focus, the mount find the object, execute a meridian flip, and then, when all was said and done, shut itself down.

Way to go.

A note about this Tutorial

Okay, you may not be a PRO yet, but you actually know enough to run a sequence over many hours, with SGP pointing, focusing, acquiring data, saving it, flipping past the meridian when needed, continuing on, and even taking darks. All unattended.

So, if you wanted to take a day of rest, it is deserved. Just let SGP image all night while you sleep.

There are, however, many other things to learn about SGP. These include ways to optimize the program to get the most of your equipment, ways to input target information and lists, wizards to help plan flats, and take mosaics.

You know the basics, and should be able to learn all of these other tools as you need them.

You should re-read the help sections and other documentation now, and go back and re-set your Equipment Profile to correct those things we left unchecked or incomplete while we were learning. Now that you have been through it, it will make much more sense to you.

This tutorial was written solely for the purpose of helping others who were starting SGP for the first time. It is impossible to imagine all the combinations of equipment, circumstances, and personalities of those who are first starting up with SGP. If this has helped you, great. If it has not, then I hope you put it aside early and did not spend too much time on it. If you see errors, or have difficulties, I need to correct or clarify things. Please send a message to me (alexmcconahay@gmail.com), and I will try to respond. Or you can try Cloudy Nights, where I check in much more frequently.

Good luck.

Alex McConahay

July 23, 2017

This tutorial was written originally in 2013, with Version 2.2.8 in the first week or so after I downloaded a trial copy. I rewrote it to reflect the improvements that the developers, Ken and Jared, have made. This version 3 , started in May, 2017 using 2.6.021, updates the screen shots and changes some procedures to reflect changes in the software and icons.

Equipment I have used with SGP in developing this tutorial include:

QSI 583 WSG (internal filter wheel and guider) with Narrowband and LRGB filters.
Canon Eos 450 and 6D
Robofocus
Optec TCF
NP 101 on Losmandy G11 at home observatory
Meade 10 inch F4.5 Starfinder Newt or TPO 12 inch RC on AP1200 in desert observatory
Dell Inspiron Laptop (Windows 7)
Lenovo G575 Laptop (Windows 7 and 10)