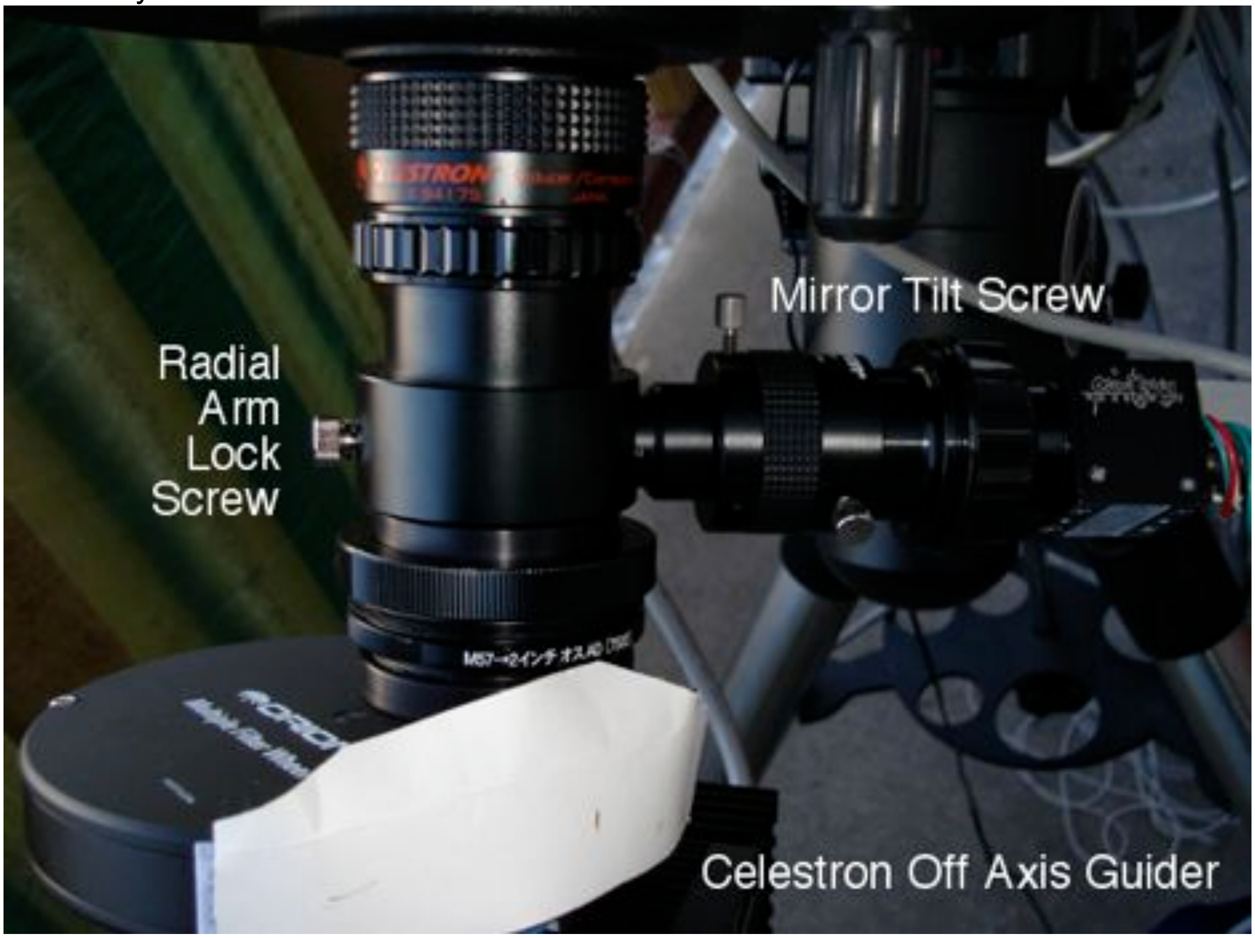
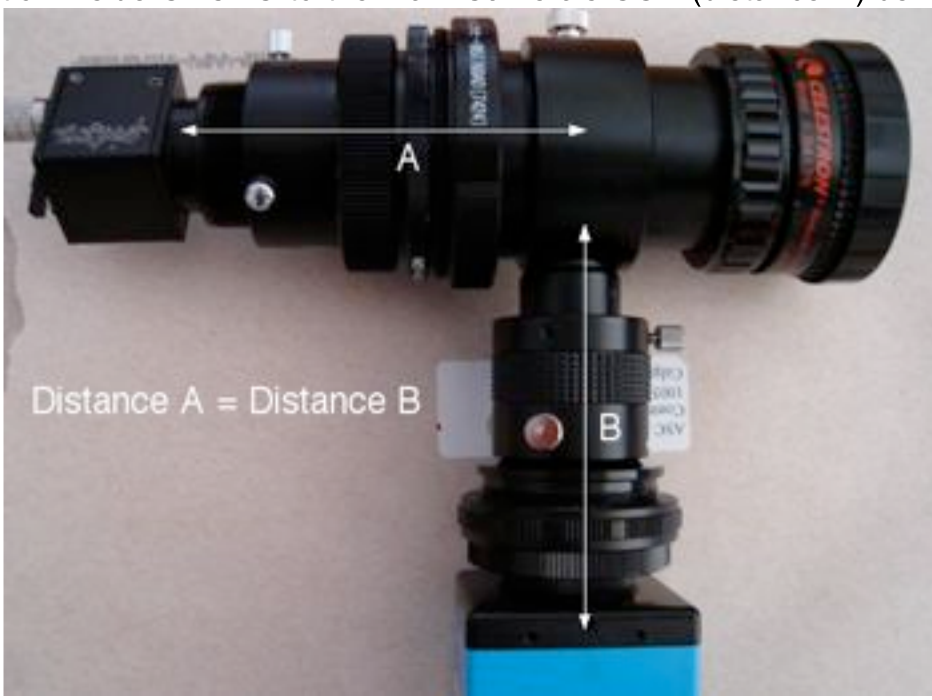
This is a brief guide on how how I use my **Celestron Radial Off Axis Guider** (CROAG).

The CROAG is unique in that it allows you to rotate the guide camera arm 135 degrees radially around the axis and tilt the prism (mislabeled Mirror) angle too. This means it's fairly easy to find a suitable guide star within the "View Donut" without having to unscrew and rotate the camera, which would force you to reshoot your flat frames if you rotate the OAG.



1) Getting Both cameras in focus.

The first thing you need to do is determine if you need to add or remove any spacers between your Guide camera and the prism. So we determine the approximate distance form each camera to the prism. First we measure the distance from the prism position inside CROAG to the main Camera's CCD (distance A) using a ruler.



Next measure the distance between the prism position inside the CRAOG to the Guide camera's CCD (distance B). If the "B" distance for the guide camera is too short, then you may need to add in a spacer or slide the 1.25" nosepiece out further. At this point, your reasonably close to getting both Cameras in focus.

The next step is to fine tune the focus for both cameras. I find this easiest to do during the day or near dusk using a distant terrestrial object, like a single vertical tree, a street light, a cell phone tower or even a building edge as a target (Other people find it easier with the Moon or bright open star clusters, I don't). Attach both cameras and them make sure the OAG arm is oriented the same as the vertical target is. Move the mount until the target is in the main camera's field of view and then focus it on some feature. After that, move the mount up and down until the edge feature appears in your FOV of your OAG Camera. Next slide the 1.25" nose piece in or out of the guiders until you have achieved close focus.

2) Determining Camera field of View.

The next thing you will likely want to do is determine what your primary Camera and Guide camera's field of views are. Since most people use a focal reducer with extension tubes, filter wheels or filters, it is important to measure the actual arc seconds per pixel. As you increase the distance between the CCD and the Focal reducer, the shorter the effective focal length becomes, so until you have measured it you don't know the FOV of your camera.

The way I prefer doing this is to take an image with each camera of a field of stars that you know the arc seconds distance between. For example the distance between Mizar and Alcor in the Big Dipper is 11' 48" or 708 arc seconds, but you can use most planetarium type application to measure the distance between any convenient stars. Next you need to measure the pixel distance between two stars in each image using a drawing package in pixels. I use the AppleWorks drawing module for that. Once you have the arc seconds and the pixel distance, divide arc seconds by pixels and you know the number of arc seconds per pixel. Your field of view becomes:

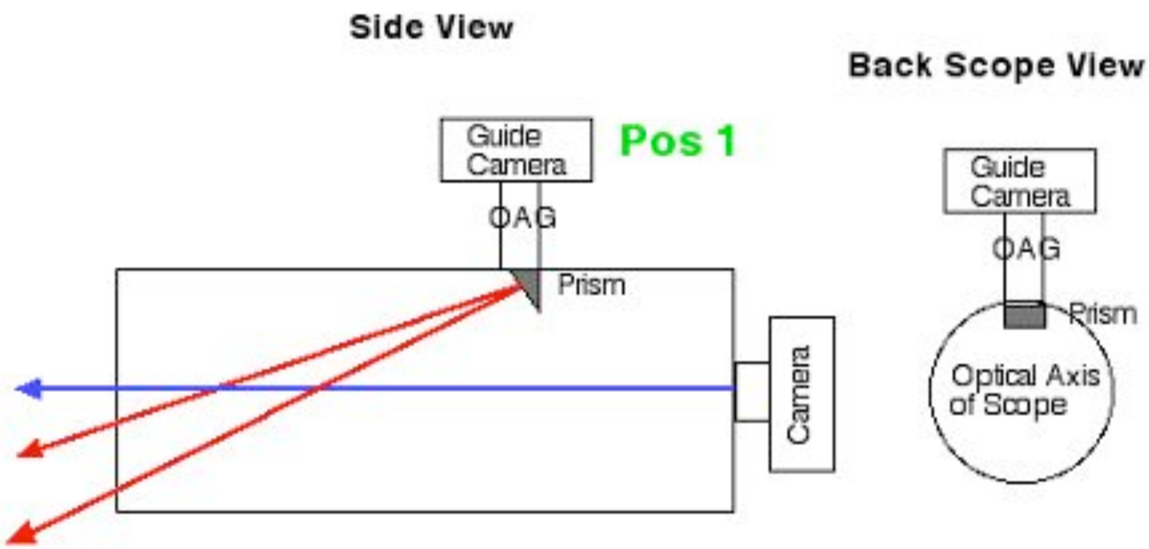
width in arc seconds = #camera pixels wide * arc seconds per pixel.
height in arc seconds = #camera pixels height * arc seconds per pixel.

Now you know the cameras true field of view in arc seconds.

3) Determining Prism Range of Motion.
The next thing you want to do is to determine the range of motion in arc minutes of the CROAG when you twist the prism angle screw in or out.

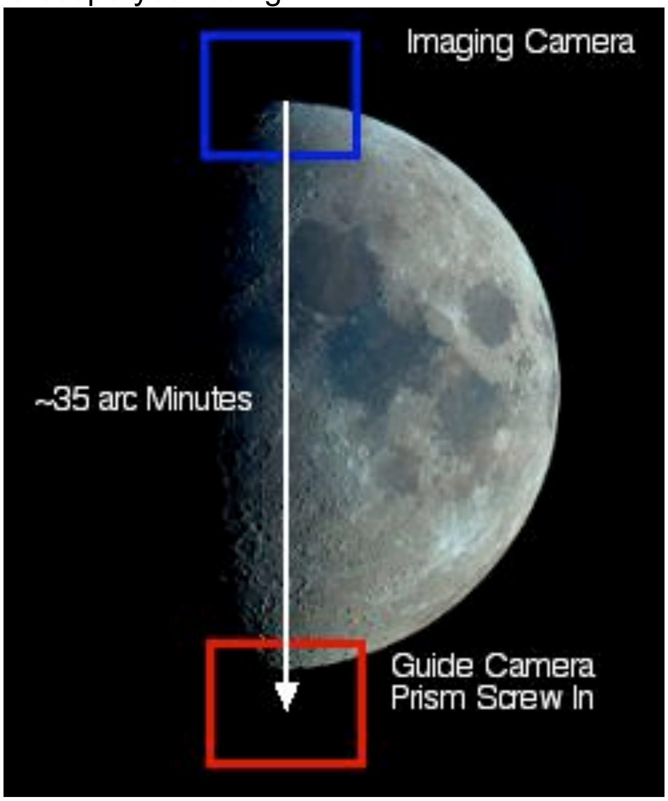
I find the easiest way of doing this is to use the moon as your target. The moon is approximately 30 arc minutes in diameter and quite bright - so it's an easy target to calibrate with.

Basically, you want to have both the imaging and guiding cameras hooked up to your computer and running at a reasonable frame rate. Then orient the CROAG arm so it's aligned along the Moons Terminator and oriented upwards, as shown below.



The red lines show where the Prism is looking as you twist the screw, which is actually the opposite side that the Arm is oriented on. If the guide arm is north (or above) of the imaging camera, then your actually looking south (or below) the imaging Camera. Next twist the Prism adjustment screw all the way in - which forces the prism to look downwards, so that we are looking at the furthest distance away from the imaging camera.

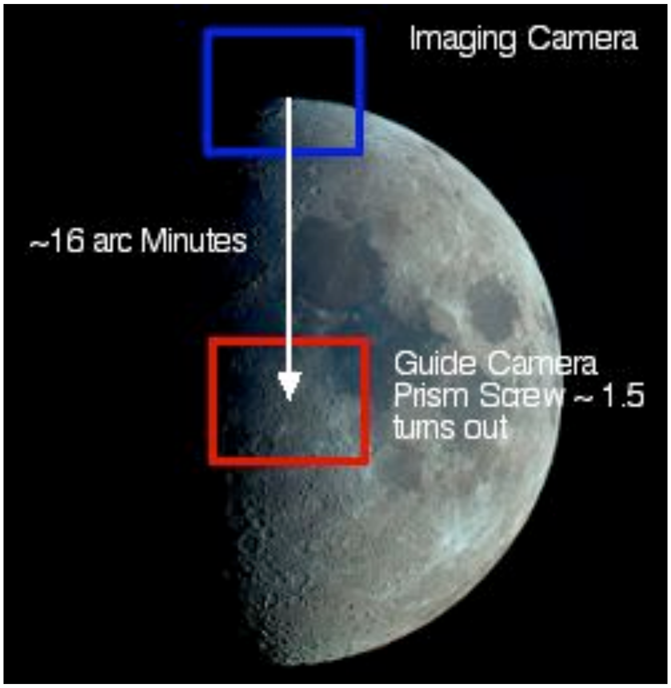
Now you want to slew your telescope so that the North limb of the moon is centered in the imaging camera's FOV (adjusting focus if necessary), as shown below for the "Blue" box. What you actually see will depend on the Camera FOV in arc minutes and the focal length of the scope your using.



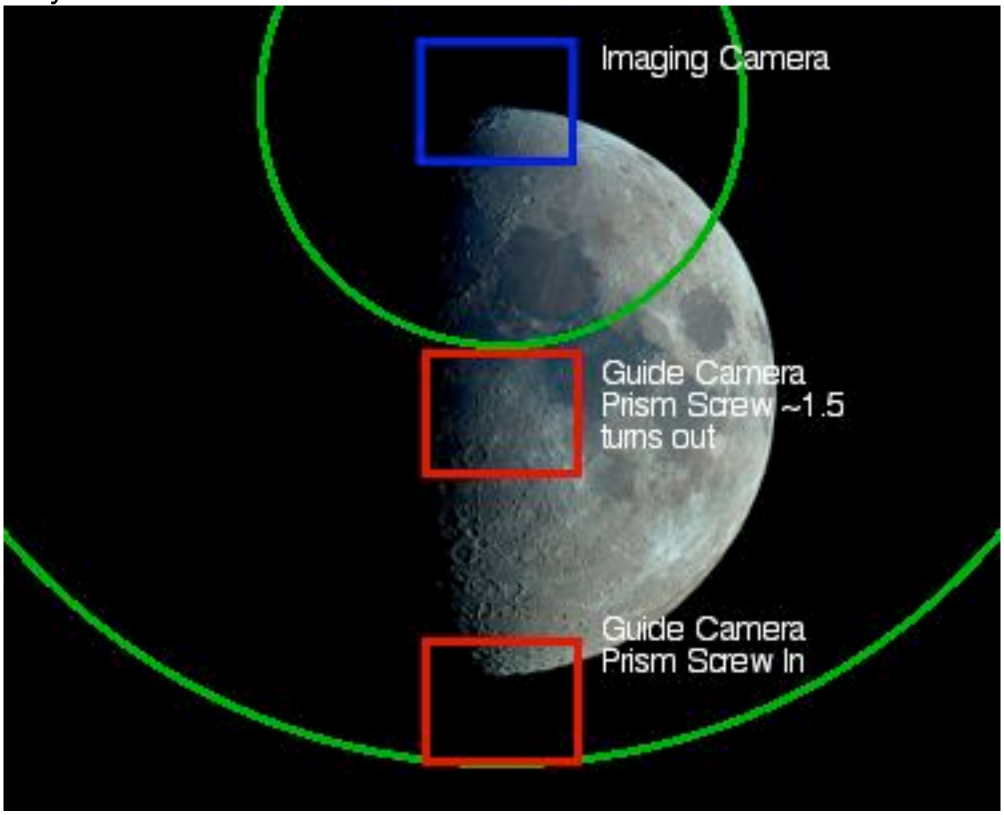
When the prism adjustment screw is all the way in, the prism will likely be pointing at the inner wall of the CROAG's tube, so the guide camera will likely just be showing a black image. We need to twist the screw out about 1/4 or 1/2 of a turn until you start seeing the moon appear.

At this point, the "Red box" FOV is the maximum distance that the Guide camera can see below or outside the Imaging Camera. In this case it's ~ 35 arc minutes (1.1 times the moons diameter) from the center of the Imaging Cameras FOV to the Guide Cameras FOV.

Now we need to determine the inner distance we can see, and you should slowly twist the Prism adjustment screw outwards. As the Prism changes angle, you will see different parts of the moon. Eventually (after about 1 to 1.5 turns of the screw) the moon will start darkening as you reach an area of vignetting and that is your minimum distance, as shown below.

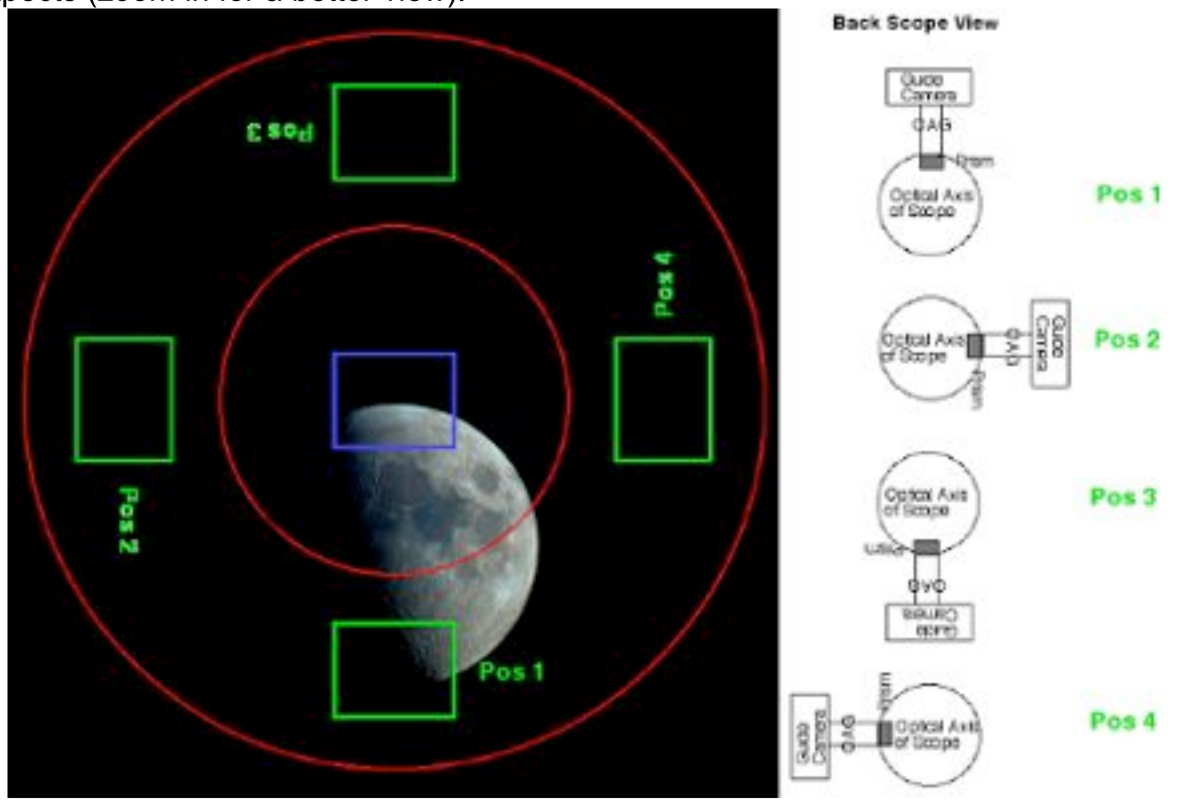


In the above example, it is ~ 16 arc minutes (roughly 0.5 times the moon's 32 arc minute diameter) between the centers of the Imaging and Guide Camera's FOV. Now that we have these measurements, we know know the range is 13 to 36 arc minutes as shown by the Green circles.



To make use of this information when planning an imaging session, you would enter the two circles as 13 and 36 arc minutes radii in your Planetarium software as FOV indicators and then use them to determine what stars can be used for guiding.

4) Positioning the Radial Guider Arm.
As I mentioned before, the position of the Radial Guider Arm is opposite to what one expects (zoom in for a better view).

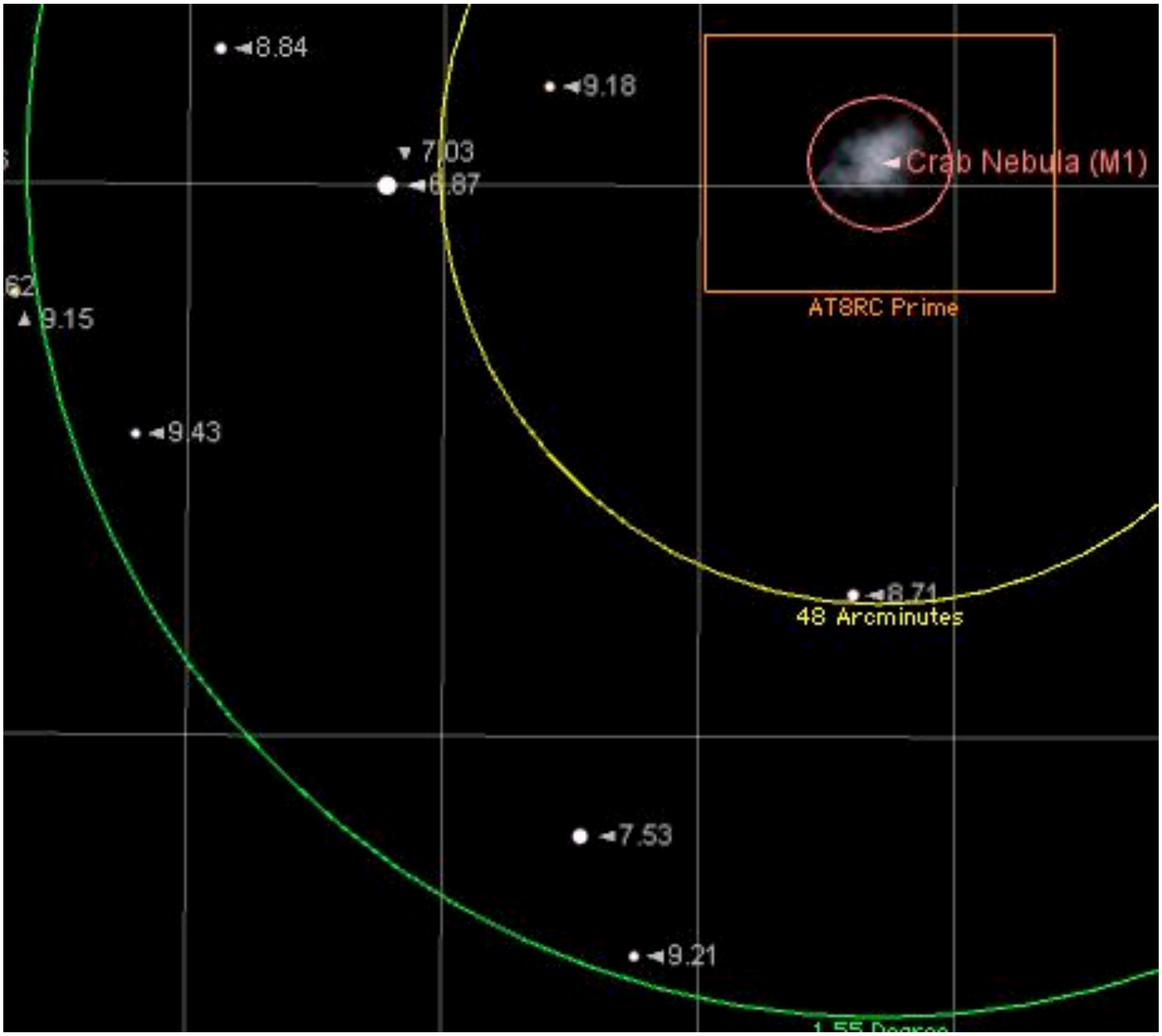


In the image above, the "Back Scope View" on the right is how the Radial Guider Arm is oriented from "Pos 1" (North Top) to "Pos 4" (East Left) relative to the Imaging Camera.

The Left side of the image shows where the Guide camera would looking for each of the Radial Guider Arm's position.

So you can see that if you want to find a guide star that is south of your intended target, then you need to orient the Radial Guider Arm so it's north of the Camera.

5) Picking Guide stars.
In the example below using Starry Night Pro Plus 6.4.3 as the Planetarium software, I have two bright guide stars that are within my inner / outer CROAG radii around M1 the Crab Nebula.



For the Mag 6.67 guide star east of the Crab, I would rotate the Radial Guider Arm so it was oriented due west to get the OAG pointing in the right direction. Then I would rotate the prism screw all the way in to a known starting point, and then rotate it about 1.0 to 1.5 turns outwards so the prism is now at the minimum distance. That should put the Guide star on the lower edge of the guide camera.

For the Mag 7.53 star SSE of the Crab, I would rotate the OAG radial arm so that it is oriented NNW to get the OAG pointing in the right direction. Then I would rotate the prism screw all the way in to a known starting point, and then rotate it outwards about 1/4 turns and the Guide camera would be pointing at my Mag 7.53 guide star.

6) Miscellaneous Things.

There are three small screws on the CROAG that need mentioning, one screw on the main barrel that locks the vertical position of the Radial Arm and prism on to the main barrel, and then two screws on the Radial Arm that lock the prism's orientation relative to the main barrel. The "main barrel" is the part that attaches to the back of the telescope and that the filter wheel / imaging camera will attach to.

If you loosen the vertical position screw, you can raise or lower the prism in the light path. The only time you would likely need to adjust this when you have a large CCD and the prism is obstructing part of the light . This means you now have a faint shadow cast on the CCD and as you rotate the Radial Arm, the shadow moves too. That means you need to shoot new flats each time you move it.- which defeats the purpose of having the movable arm. The best way to make sure it isn't happening is to shoot a series of Flat frames with the Arm rotated though 135° in say 45° chunks and see if the shadow shows up when the image is stretched to bring up contrast.

Hopes this helps you in your imaging..

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