All Weather
SEEING MONITOR

Figure One: Seeing Monitor

Professional observatories often employ a monitor to determine the quality of seeing each night. This can be useful in helping to decide whether to take certain kinds of images, or whether to image at all. If you happen to be at the observatory you can sometimes just look through an eyepiece and see whether the night "looks" good or not. But more and more of our customers are mimicking professional observatory installations with remote observing sites and fully automated observing systems. Remote can mean anything from a few meters to a few thousand kilometers.   No matter where one observes, it is often a time consuming matter to get ready for a nights imaging session. It would be convenient to know before hand what kind of results one could expect. Even if the expectation was that the night's seeing would be no better than several arc seconds, the type of imaging one decided to set up for could be changed to make the best use of the conditions available for that evening.

Figure Two: 10 second image of Celestial North Pole and Polaris

SBIG has developed an automated unit for monitoring and logging the seeing throughout a night. The Seeing Monitor, pictured on the right, uses the same ST-402ME camera board and weatherproof box as the Meteor Camera with some different optics and different software. The Seeing Monitor is intended to be set up once and left outdoors for an indefinite period.

The Seeing Monitor uses an uncooled, shutterless version of the ST-402ME mated to a 150 mm focal length F5.3 lens inside the weatherproof box. The box also contains a USB extender, and a 12 VDC power supply for the camera. The window in the top of the box is clear.   The window is heated to prevent condensation on the outside. The USB extender allows operation up to 150 feet (50 meters) from the controlling PC. The lens and box is permanently pointed at Polaris by the user. It is assumed the user will mount posts in the ground outside his observatory or home for this purpose. Roof mounting is not recommended because small vibrations from the building may affect the monitor's measurements.

When properly aligned, one will get an image of Polaris as shown in Figure Two. Of course, Polaris is not eactly at the pole. The field of view is just large enough that the entire orbit of Polaris about the north celestial pole can be captured no matter what time of night the measurements are taken with the camera set up on a fixed mount.

Figure Three shows a sequence of images over a night superimposed. The position of the pole is now quite apparent.

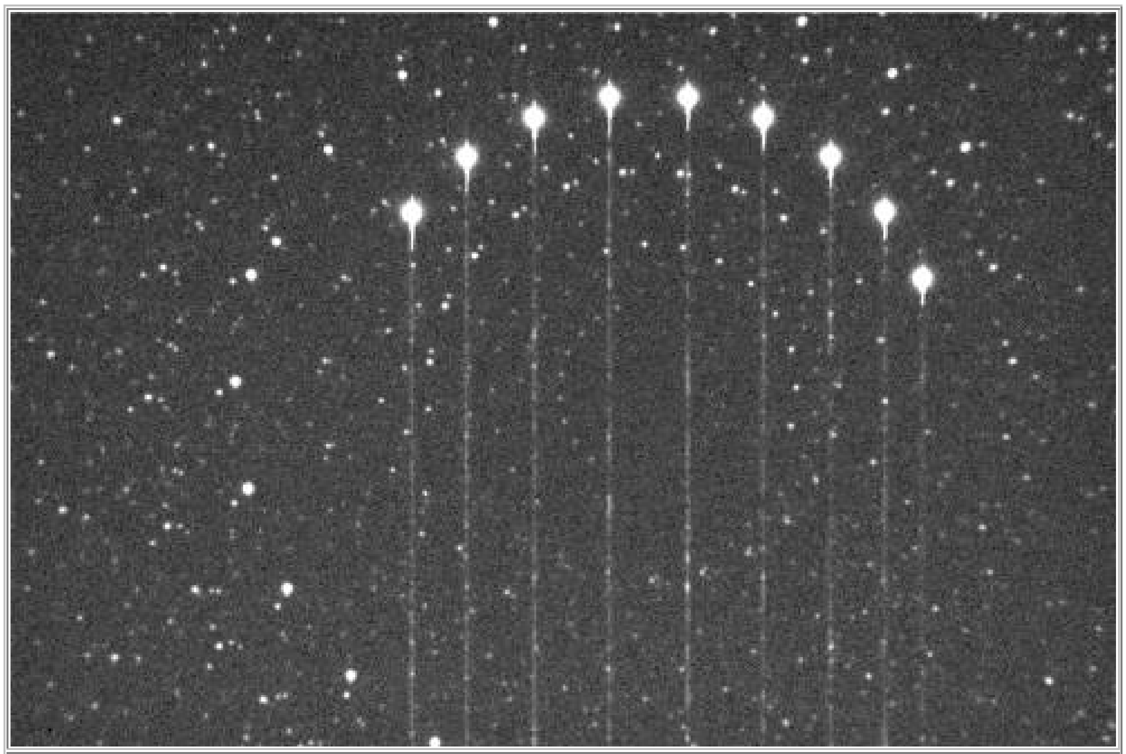

Figure Three: Sequence of 10 second Images Superimposed

The streaks below Polaris in these images are due to the fact that the camera is shutterless and Polaris is exposing the CCD while it is being read out. This has no effect on the calculations for this application. Also, there is no need to take dark frmaes for such short exposures. This system is used to measure the seeing by measuring the hoizontal jitter in the position of Polaris at high speed. A set of equations then can be used to calculate the zenith Full Width Half Maximum (FWHM) that one will obtain in a long exposure image from the rms jitter. The jitter is measured by reading out the CCD while it is being exposed by the light from Polaris in Time Delay and Integration (TDI) mode. An example of the resulting image is shown in Figure Four.

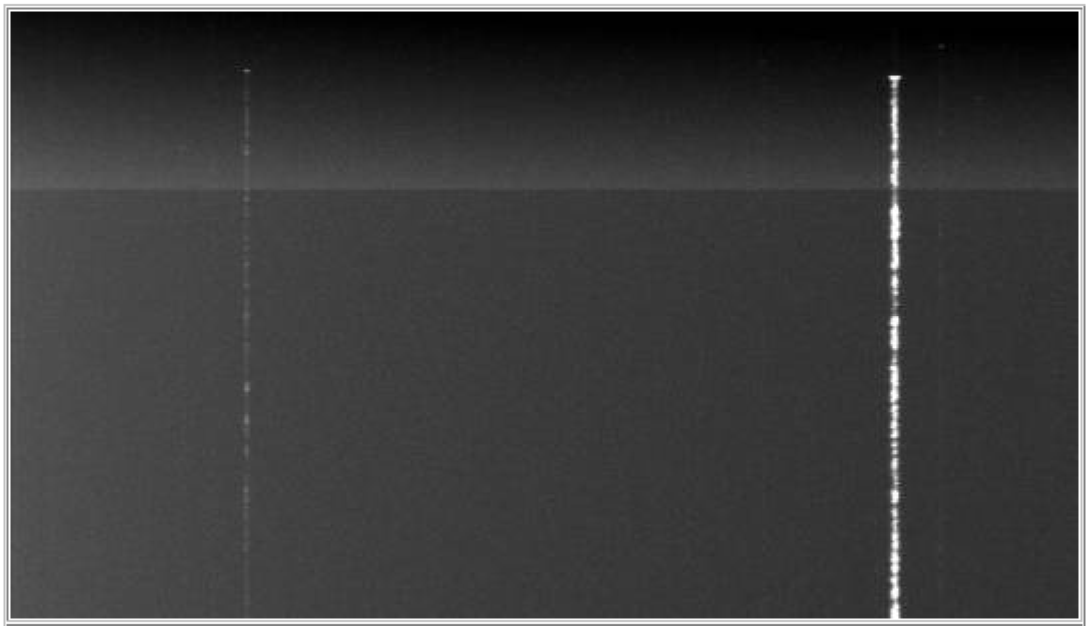

Figure Four: TDI Readout Image of Polaris

Polaris leaves the bright streak on the right. The CCD is binned vertically by 4 pixels, which causes the start region to be compressed into the top third of the frame shown here. The data below Polaris is fluctuating wildly in brightness due to scintillation, the same effect that causes stars to "twinkle". What is not obvious here is that the line is being deviated left and right as Polaris's position is perturbed by seeing. The software measures this perturbation, and automatically calculates FWHM at the zenith. The readout is fast, so a new measurement of Polaris' position is being obtained every 5 milliseconds. This is important, since too slow a rate will underestimate the seeing jitter due to exposure averaging.

The results can be very revealing. For example, at the test site, we have two kinds of clear nights. The first, most common, clear night is a two to three hour period between sunset and the fog coming in from the ocean like a wall. The second is when we get “Santa Ana” winds off the mountains behind Santa Barbara, which is a hot wind characterized by really clear, but highly turbulent air. It can get pretty good after midnight. In Figure Five, below, a graph shows how good it got one night while monitoring with the seeing monitor. What started out as a night with rather poor seeing turned into a very good night after about 1:00 AM.

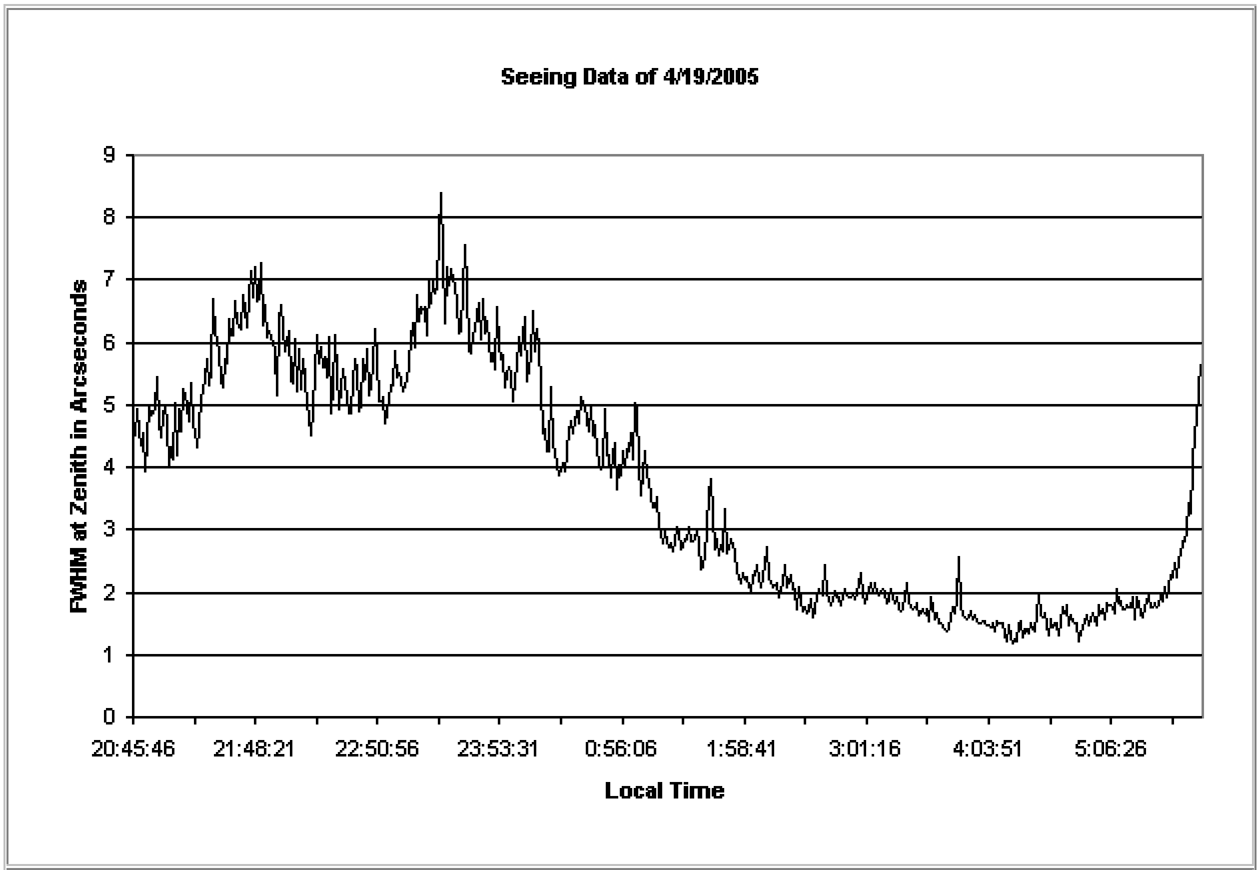

Figure Five: Excel Spreadsheet showing Seeing over a “Santa Ana” Night

This kind of information can be very helpful for remote imagers or anyone who must decide whether it is worth it to begin a nights imaging session, and if so, when. It can also signal when a night is degrading to the point that it is not longer worth the effort of continuing the next hour long series of exposures.