Astronomical Adventures

An Occasional Series on Building, Outfitting and Operating a Remote Observatory

By Manny Leinz

The first four parts of this series detailed the initial steps to realizing my dream of building a remotely operable astronomical observatory at our vacation home in Mariposa, Ca. Episodes 1 - 4 covered planning, building, initial outfitting and initial steps toward autonomy and were featured in prior issues of Prime Focus, starting in 2019.

Episode 5 – Pausing for an Upgrade

I've been an amateur astronomer for a long time — over 30 years—but during that time I've had only two scopes that I would consider "large"—10 inches or above. The first, which I purchased second hand back in the 1980's, was a 10 inch Meade LX-6. It served me well, but eventually I wanted something with more modern electronics and "Go-To" capability.

In 2005 I bought a Celestron CGEM 1100, which features an 11 inch Schmidt Cassegrain Telescope (SCT) Optical Tube Assembly (OTA) and a "Go-To" German Equatorial mount. Over the years this has been somewhat of a 'love-hate' relationship, particularly with the mount. The OTA gives excellent views, but primary "mirror flop"—a common issue with SCT's—can cause the image in the eyepiece to spontaneously shift. This is tolerable for visual observing, but a hindrance for astrophotography. The mount has been problematic and suffered from numerous issues including a shorted power connector, failed optical encoder and a hand controller that "bricked" and became unusable during a firmware upgrade. The mount would also occasionally exhibit "runaways"—spontaneously slewing toward a hard stop—which sent me diving for the power switch.

To their credit, Celestron took the mount back for service numerous times free of charge, even after the warranty period, and did their best to address the problems, with limited success. Nevertheless, the mount was marginally reliable and not something that I felt could be trusted in a remote observatory.

As I began to make progress automating my observatory—see Episode 4 in the May 2020 issue of Prime Focus—I decided it was time to upgrade to a new mount and telescope. Let the search begin!

A New Scope and Mount

In deciding what telescope to buy, I considered a number of factors. My primary use for the new scope would be for astrophotography. Since I still consider myself a beginner, I wanted a scope optimized for wide field work. A wide field scope—short focal length and low focal ratio—simplifies pointing and is more tolerant of tracking errors. I also wanted as large an aperture as possible, to gather more photons and thus reduce exposure times for dimmer targets. Lastly, I wanted to to keep the price reasonable, to retain some budget for a precision mount.

I quickly came to the conclusion that for me, the best combination of the above features was to be found in the relatively new design Celestron RASA. The RASA—Short for Rowe-Ackermann Schmidt Astrograph—looks at first glance like an SCT, but there are important differences. Most significantly, the camera mounts to the *front* of the telescope. This factor, along with the unique optical design of the scope, enables a very "fast" focal ratio of f/2.2. With an aperture of 11 inches, the RASA provides a wide diagonal field of view of 2.1 degrees with my ZWO ASI294MC Pro camera, and it is reasonably priced considering its unique capability.

One downside is that the scope is strictly for astrophotography use, as there is no way to fit an eyepiece to the scope without blocking the aperture. I was willing to accept this limitation, as my observatory was designed from the outset to be fitted with a second pier, which I plan to use primarily for visual astronomy. It will provide a good home for my venerable CGEM-1100! Another consideration is that mounting a filter wheel—for color imaging with a monochrome camera—would partially block the aperture. At least initially this is not a problem for me, since the ASI294 is a one-shot color camera.

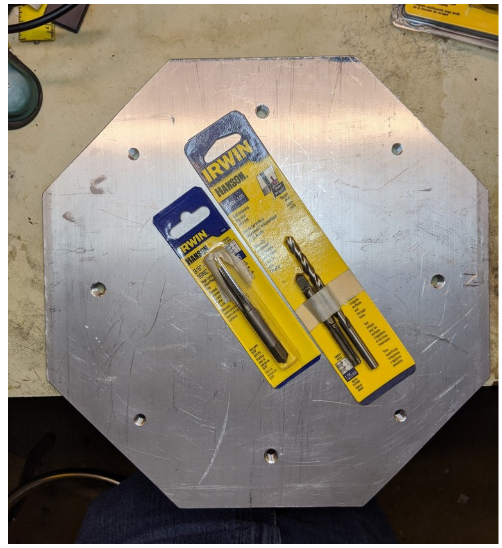
I put a lot of thought into the selection of the mount, since it will be critical to reliable operation of my remote observatory. I wanted a high payload capacity in order to accommodate the RASA-11 OTA, camera, guide scope focuser, etc. I also wanted sufficient payload margin to support a larger scope in the future. I settled on 100 pounds as a target. Perhaps as a result of my experience with the CGEM, I decided on a mount with absolute encoders, so that even under a power loss condition, the mount would always know where it is pointed. Low periodic error was also a consideration, to ease requirements for precision guiding during long exposures. Cost is always a factor, of course. A mount that met the above requirements would not be cheap.

After quite a bit of research—and helpful guidance from some RAS club members!—I finally settled on the Ioptron CEM120-EC2. With a 120 pound payload capacity, absolute encoders in both R.A. and Dec and a periodic error spec of less than 0.15 arc seconds RMS, it met my requirements at a price point I could afford.

I received the Ioptron mount in May of this year, and the RASA in June. I was excited to get them installed and operational!

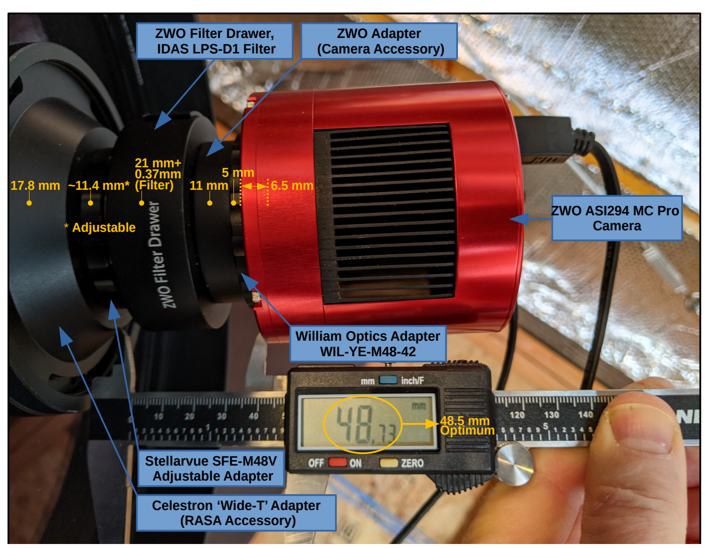
Installing and Configuring

Installing the CEM120 on the pier in the observatory was straightforward. The mount attaches with four thumbscrews from the top, so a simple flat aluminum adapter plate with eight tapped holes—four for the pier and four for the mount—was all that was required. I used a chop saw with a diamond blade, drill press, and hand taps to make the adapter plate.



CEM120 to Pier Adapter Plate - Ready for Paint

With the aid of a helper, mounting the RASA-11 was simple as well – the three dovetail clamps on the mount provide a secure grip. Mounting the camera to the front corrector plate required some careful planning, however. As a consequence of it's optical design, the RASA has a very tight 'back focus' requirement. The distance between the camera focal plane and the scope corrector plate must be held to 72.8±1 mm to obtain good focus across the entire field of view. To meet this requirement I used a combination of adapters, including a filter drawer with Light Pollution filter. As shown below, subtracting the 17.8 mm thickness of the Celestron 'cone' adapter, plus the 6.5 mm spacing between the camera housing and focal plane yields a target spacing of 48.5 mm for the remainder of the stack.

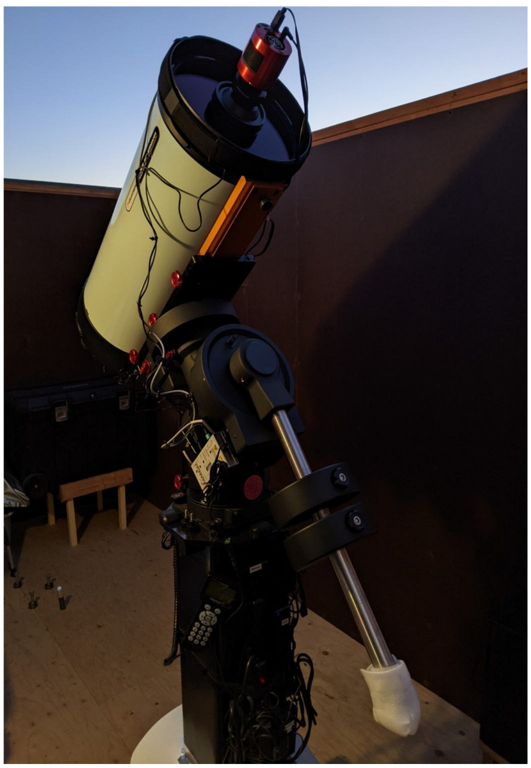


Achieving Proper Back Focus Was a Project in Itself!

To complete the new RASA/CEM120 configuration I installed an Ethernet cable to control the mount, USB3 data cable to the camera, and power for the mount, camera and focuser. I used Sharpcap Pro software to align the mount's R. A. axis with the North Celestial Pole.

First Light and First Impressions

At last on June 19th, installing, configuring and aligning were complete and I tried imaging for the first time. I immediately appreciated the significant improvements from my prior setup. I was fortunate to obtain the new V2 version of the RASA, with its 'Ultra Stable Focusing System' which is true to its name. Despite the fact that the primary mirror moves to achieve focus, as it does on SCT's, I have experienced virtually no mirror flop and minimal focus backlash. Best of all, the light gathering capability of the RASA is phenomenal. Even short 15 second exposures show surprising color and detail on brighter deep sky objects.



RASA-11 Installed on the CEM120 Mount

The CEM120 mount operation is smooth, quiet and precise. The internal cable management system has eliminated the issues I have had in the past with snags spoiling astroimages.

I have not verified the periodic error performance of the mount, but my experience so far is consistent with its 0.15 arcsecond specification. The RASA/ASI294 camera combination at 1×1 binning yields an Instantaneous Field of View—the FOV of a single pixel—of 1.5 arcseconds, so an RMS periodic error of 0.15 arcsecond amounts to 1/10th of a pixel. I have been taking advantage of this fact by foregoing guiding entirely and am getting good round stars for exposures as long as five minutes.

M21 (Upper Left) and M20 Trifid Nebula - Stack of Four 15 Second Exposures, RASA-11/CEM120 Unguided

Best of all, I now have an imaging system that I feel is robust and ready to support my next steps in observatory automation.

Current work on the observatory is proceeding on two fronts: automating control of the roof and finishing the interior walls. Before the latter task could be completed however, decisions had to made on what approach would be best from a thermal standpoint: keeping the observatory insulated, without compromising the ability to rapidly acclimate to ambient temperature when the roof is opened. This will be the topic of the next installment in this series.

Next Episode: Thermal Considerations