Live-Streaming the Sun: Configuring an H-Alpha Telescope at Morehead Planetarium

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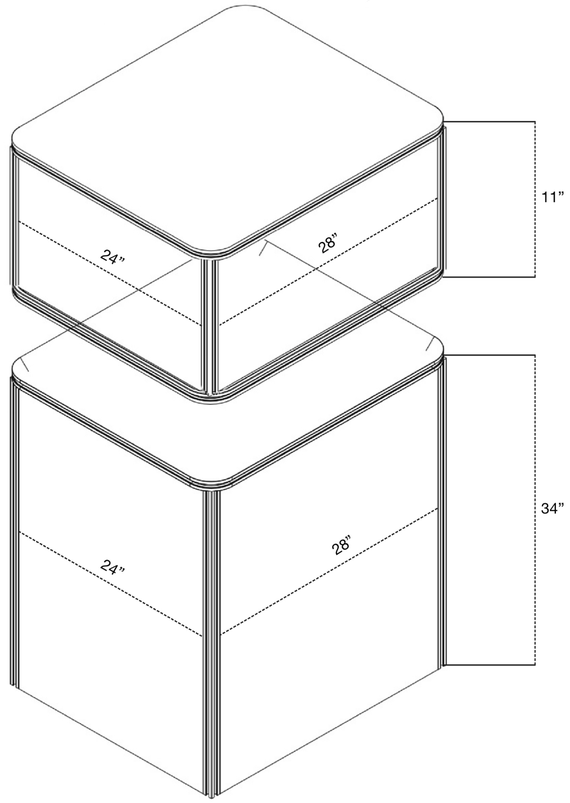
THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

Motivation

Morehead Planetarium is a Center for Space Education

Morehead Planetarium has served the Chapel Hill public for decades through plantarium shows and astronomy exihibits. The center is also home to Skynet, one of the world's largest telescope networks. The addition of the H-Alpha telescope will offer a live-feed of our very own star for public education and research.

Telescope Housing

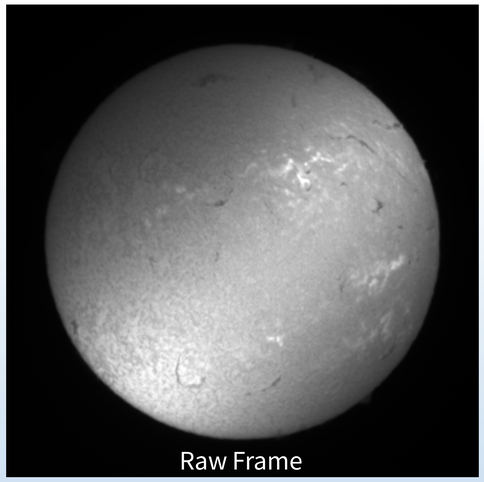


About the Telescope

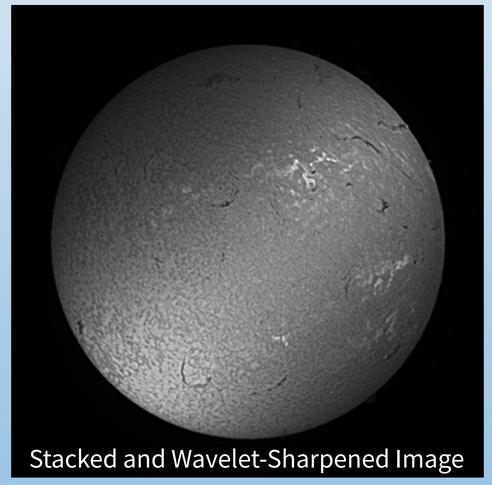
The H-Alpha Telescope is a Coronado SolarMax II 90 RichView Solar Telescope with 2 blocking filters (6563 ± 0.7 Å) and a 400mm focal length. The etalons each have an attached Servo motor that is turned via the Etalon Control GUI. The telescope is mounted on an iEXOS-100-2 PMC-Eight Equatorial Tracker System which is programed to track the sun based on latitude of Chapel Hill (36° N).

About the Housing

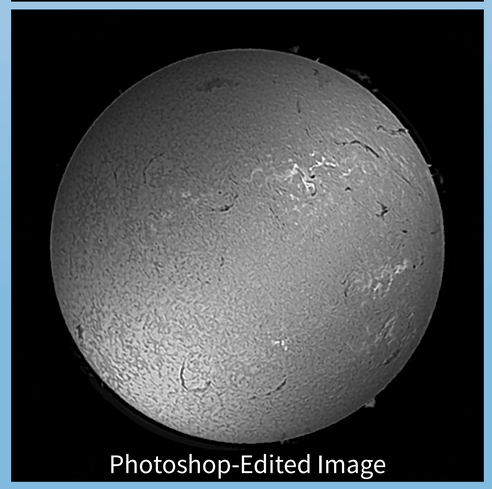
The telescope is located on a viewing deck outside of Morehead and thus requires sufficient protection from weather. The telescope is encased by a 45”x28”x24” box made of 6mm corrugated plastic and 1 sq” aluminum extrusions. The box is segmented 34” off of the deck into a stable base and an 11” moveable top-shield, controlled by a servo motor and counterweight. With the assistance of a 4’ wall around the deck, the box provides protection from heavy rain and wind. The box also houses the Raspberry Pi 4 used for control.



Raw Frame



Stacked and Wavelet-Sharpened Image



Photoshop-Edited Image

Image Processing

The image processing begins on the astroberry, which comes preinstalled with KStars. This software, in conjunction with the tracking software native to the mount, allows the CCD to collect several thousand stable images of the Sun depending on the exposure length. This file is saved to the main computer and stacked using AutoStakkert!3, which uses manually or automatically selected image features to align each frame. Next, the stacked image is opened in waveSharp 0.2 to increase the detail and sharpness of features. Finally, Adobe Photoshop applies a series of filters and layers to normalize the brightness and contrast of the disk and enhance the appearance of prominences, resulting in a high-resolution image of the Sun.

Telescope Control

A computer in Morehead monitors and controls most of the telescope/processing system, though a Raspberry Pi 4 does the heavy lifting. The Raspberry Pi, or 'astroberry', runs the sun-tracking software, and controls 3 servo motors (2 for etalons, 1 for top-shield). The etalon control GUI controls both the etalons and the top shield via a GUI that takes in a degree between 0-180 (ie: etalon angle and shield closed-opened). The Morehead computer monitors the astroberry, controls the CCD camera recording the sun, and does the image-processing.

Future Concerns

Two primary obstacles remain to be overcome. The first concerns the housing environment: though the telescope is safe from rain and wind, the box is not airtight and is susceptible to water leaks. Further, the paneling is not insulated and leaves the system vulnerable to drastic temperature fluctuations. Secondly, the image processing is not fully-automated: the applications used in processing rely on live user input and can not be operated via a script.

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References:

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Orion Telescopes
Astroberry Server