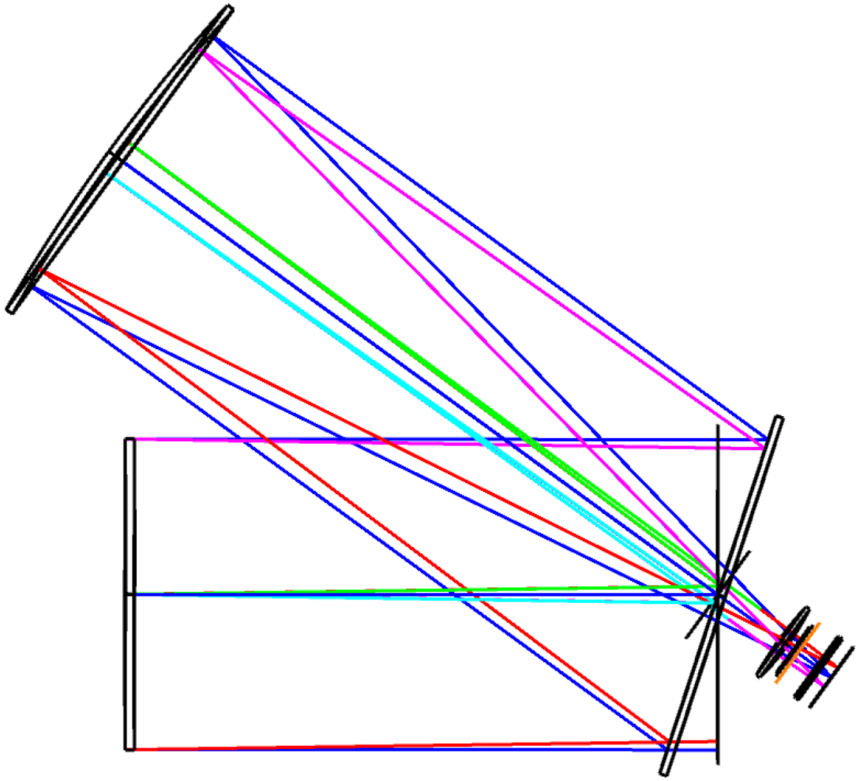
8.25” F/2.6 Astrograph Upgrades after 20 years

First Light June 6, 2005
Minarets View Mammoth California

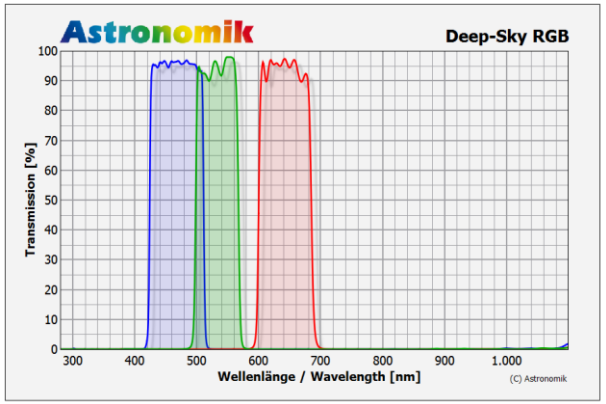
Dave Erickson

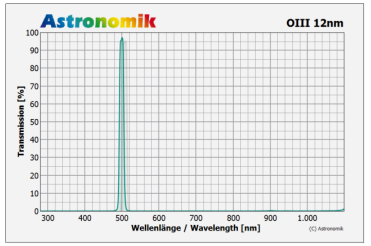
2024-2025

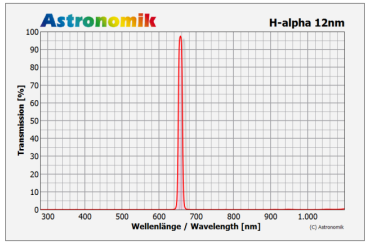


Goals

- Adapt the Astrograph designed for the SBIG STL11000M camera to newer CMOS higher performance Cameras.
- Adapt to the new Self Guiding CMOS Camera ASI2600Duo.
- Use the Improved 0.040” thick Astronomik Replacement Filters
  - Deep Sky RGB filters using Astrodon expired Patent?
  - OIII and Halpha with improved non etalon manufacturing
  - Confirm as constructed instrument performance with the new filters
- Improve baffling.
- Adapt to an external filter wheel.
- The 10” fold mirror was removed and realigned a few years back, realign again.
- Modify Traveler setup for “Pulse Guiding”. (ST4 not supported with the new camera).
- Determine filter offsets.
- Fine tuned image tilt for smaller 3.76micron pixels.
- Install remote controlled Flip Flat Cover.
- Build Flat, Dark, Bias libraries.







- Astrograph’s full potential can be reached with

2.4X smaller pixels. 3.76 micron vs. 9micron Pixels.

New Camera ASI 2600MM Duo

26 mega pixels

Sensor	IMX571
APS-C	23.5×15.7mm
Resolution	6248×4176
ADC	16bit
FPS	15(RAW8)
Full well	50Ke
Read noise	0.9e-4.2e
Cooling Temp	30°C-35°C
DDR3 Buffer	512MB
USB	3.0
QE	Color: 80% / Mono: 91%
Pixel Size	3.76μm

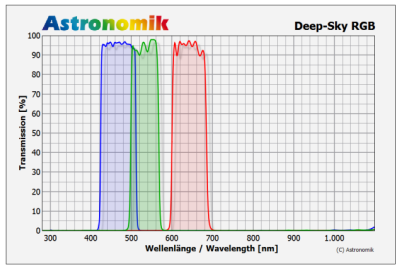
	ASI2600MC/MM Duo	ASI2600MC Pro
Sensor	SONY IMX571 SC2210	SONY IMX571
Max FPS	15 FPS (RAW8)	12.8 FPS (RAW8)
Full well	50Ke-Over 73Ke-at extended full well mode	50Ke
DDR3 buffer	512MB	512MB
Adapter	M54×0.75	M42×0.75
Guiding Mdule	Y	N

As Constructed (RGB) Zemax Performance

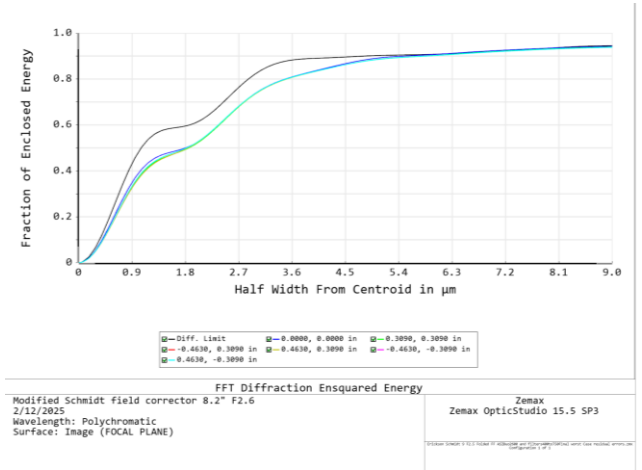
(Near Diffraction Limited Performance as constructed)

- Modified Zemax Model Based on Original Design and Construction Notes from 2005,
- Updated for New ASI2600 Duo Camera and Filters

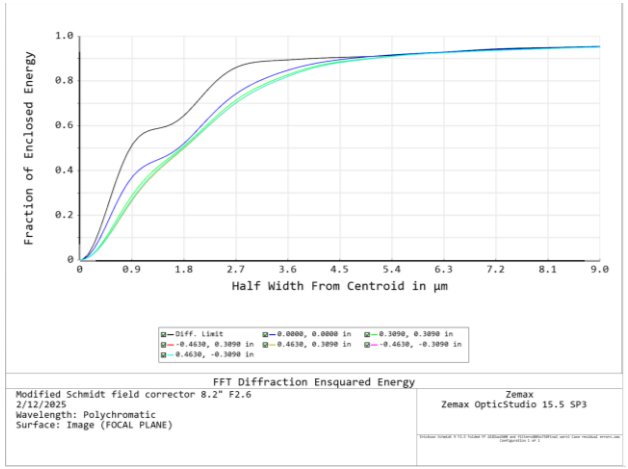
- Ensquared energy and Spot diameters for each (RGB) filter



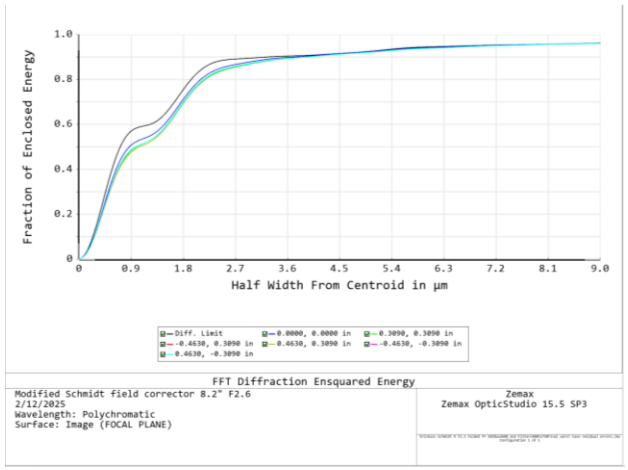
Red

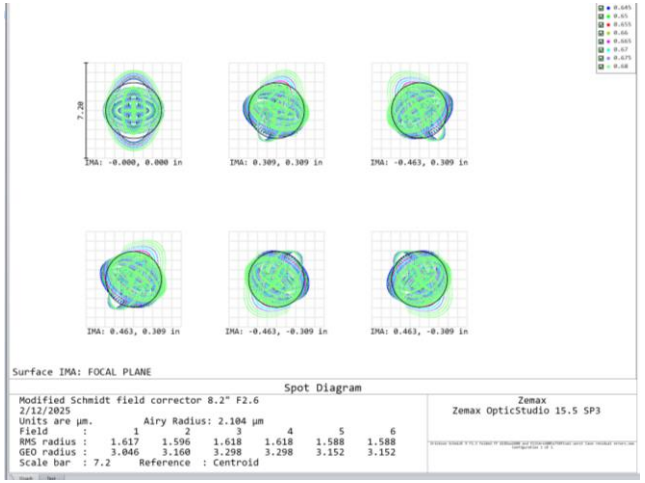


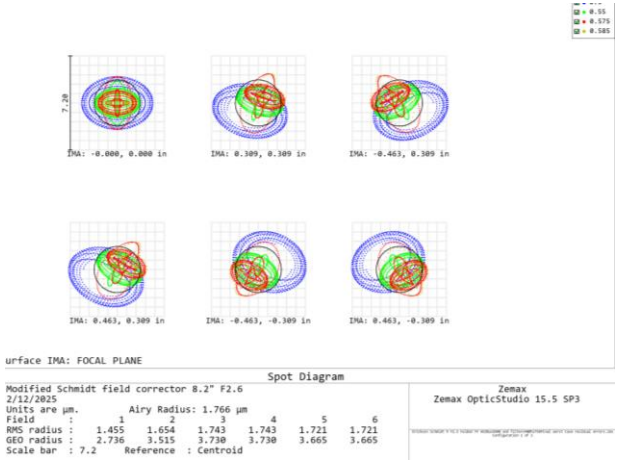
Green

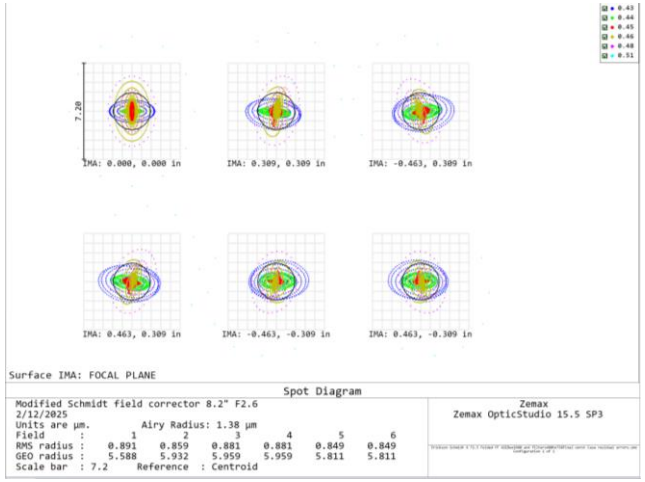


Blue





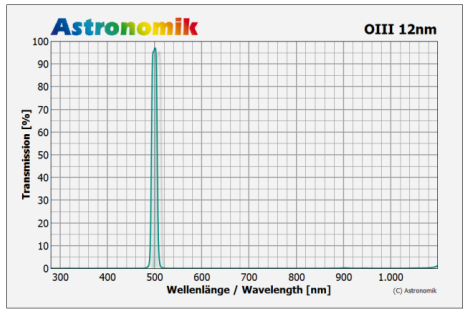


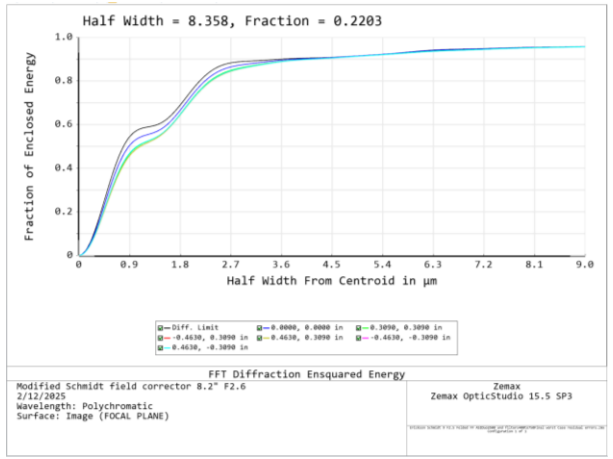


- Near diffraction Limited Performance

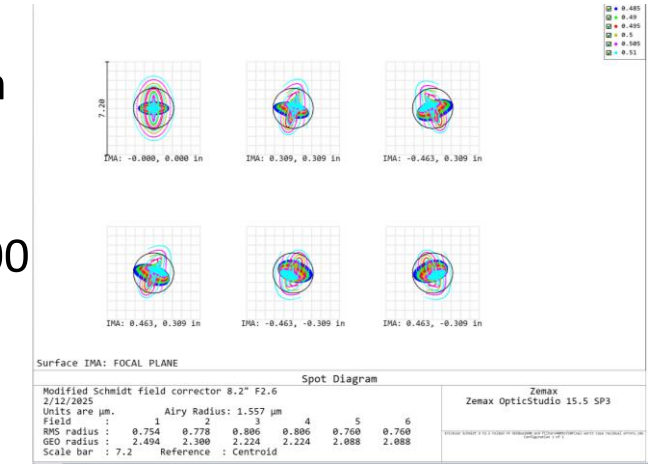
As Constructed 12nm OIII and Halpha Zemax Performance

OIII

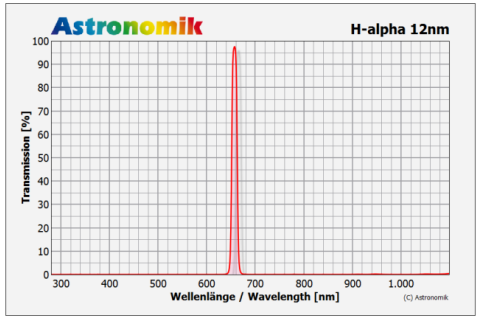


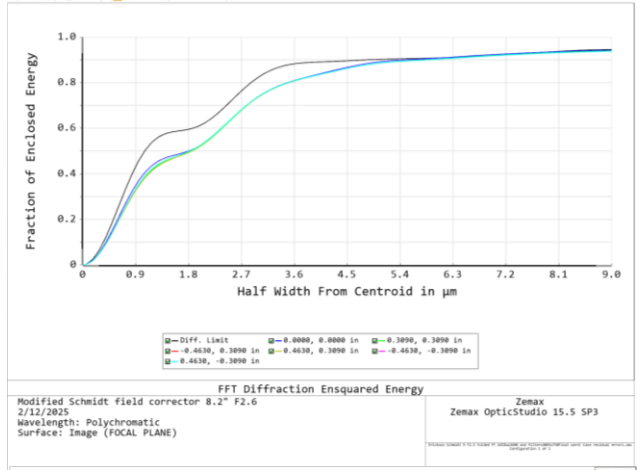


- Modified Zemax Model Based on Original Design and Construction Notes from 2005,
- Updated for New ASI2600 Duo Camera and Filters

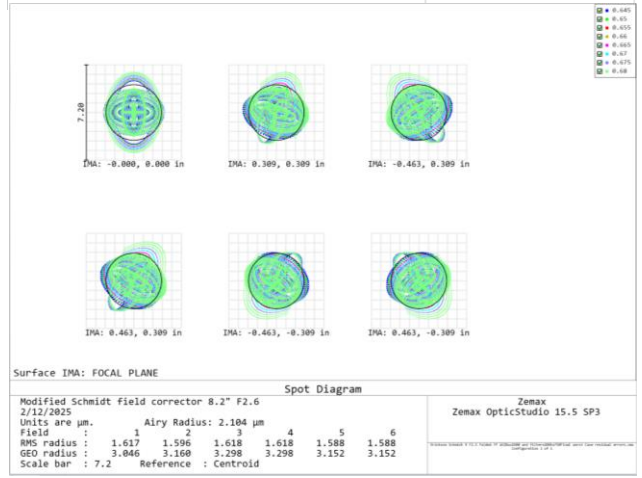


Halpha



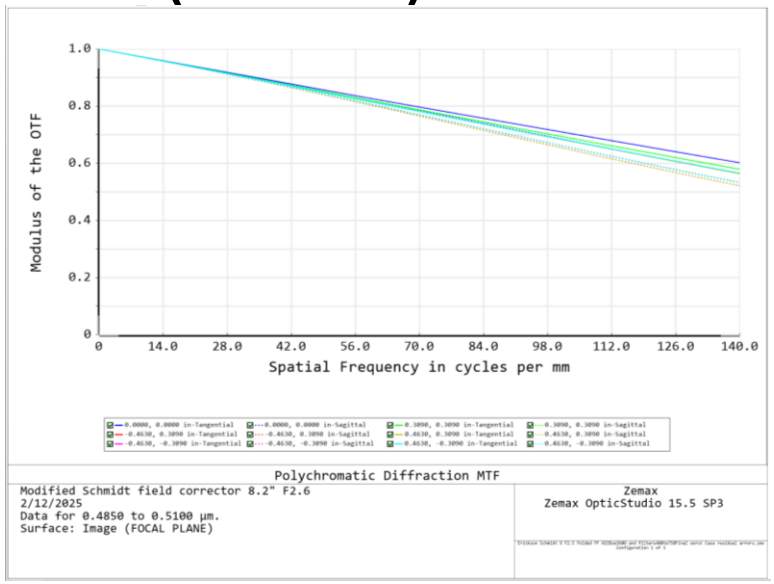


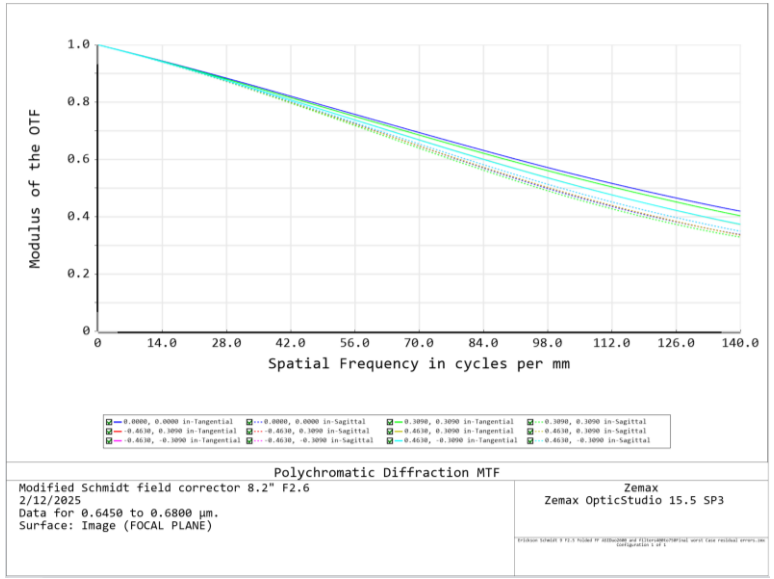
- Near diffraction Limited Performance



Modulation Transfer Function (MTF)

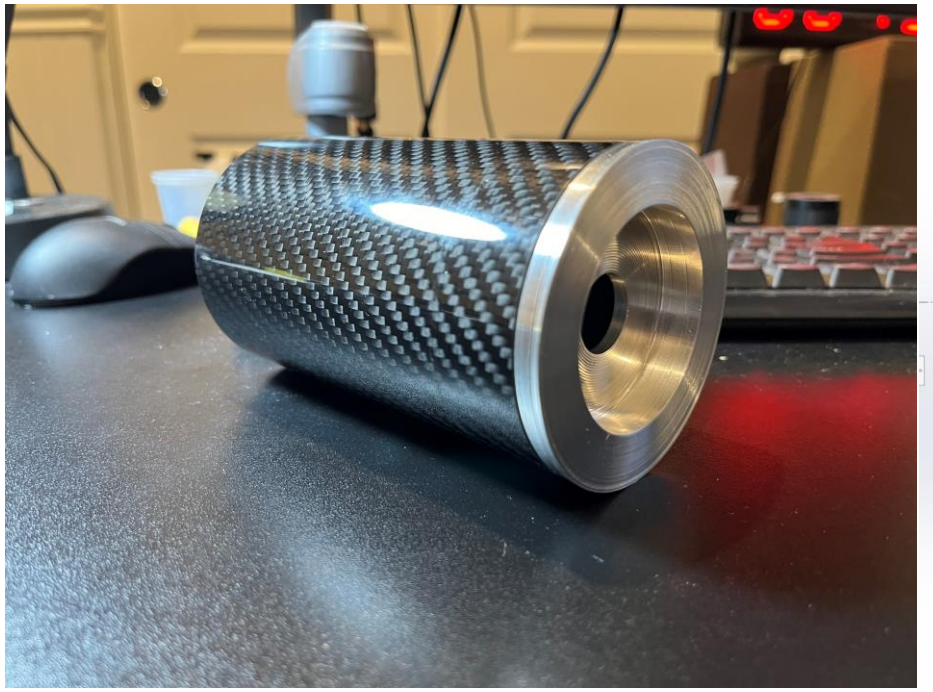
- MTF better than 50% at Nyquist using OIII filter
- MTF better than 35% at Nyquist using Halpha filter
- Nyquist = 133pl/mm 0.00376 pixel pitch
- Outstanding Image Contrast
- 2.8 arc sec resolution
- (old resolution 6.75 arc sec with 9 micron pixels

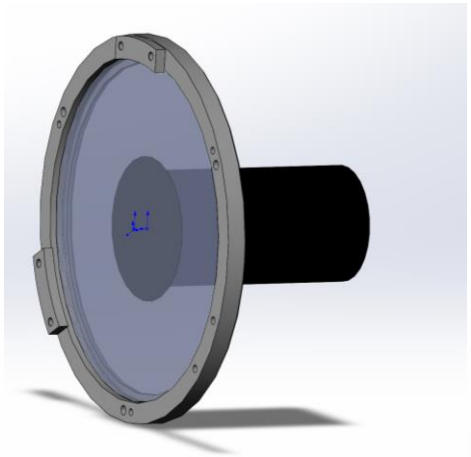


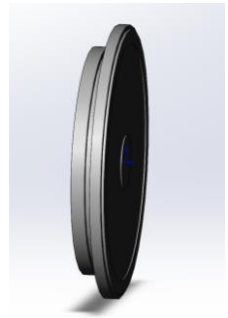


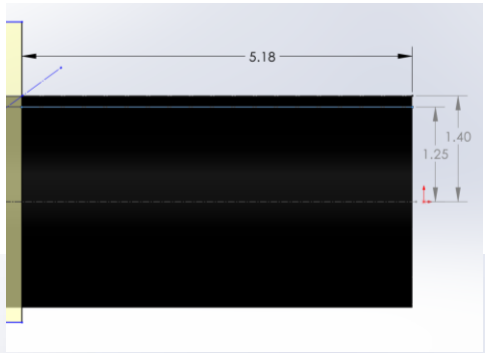
Optical Layout Corrector Mounted Baffling

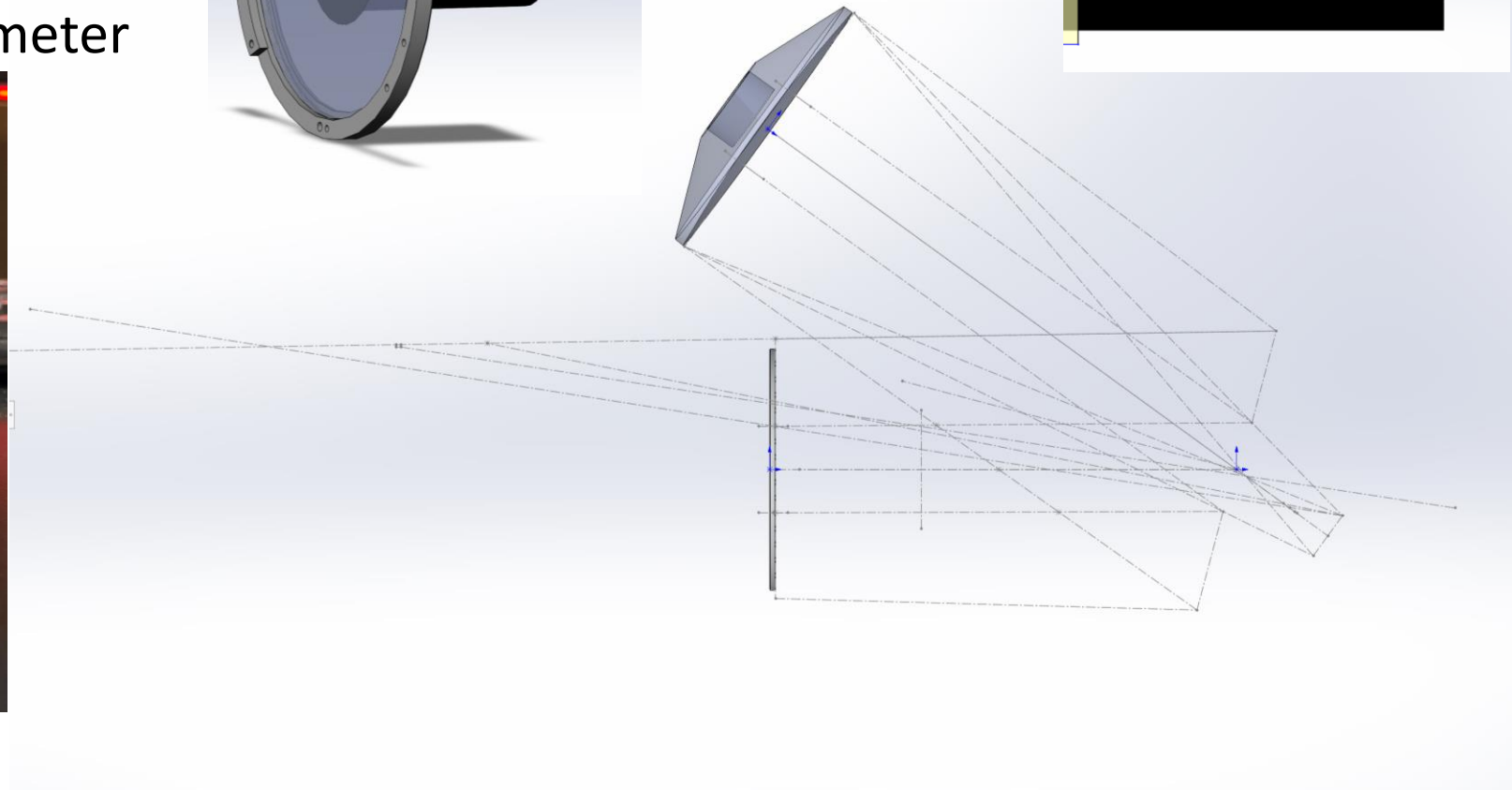
- Carbon Fiber Tube Baffling
  - Mount to the corrector plate
  - Rectangular cross section
  - 5.18” long and 2.8” diameter











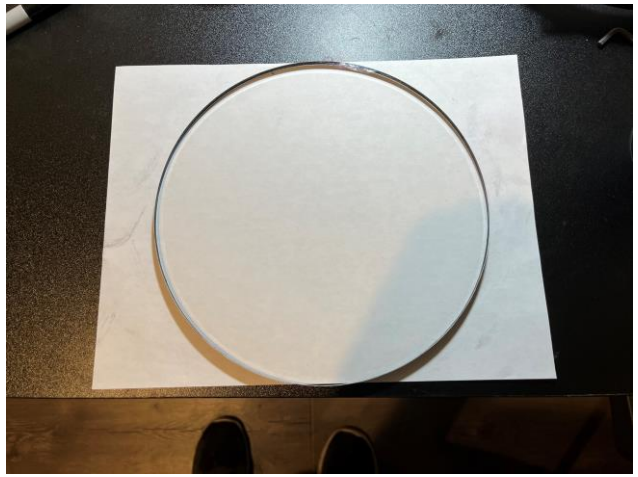
Corrector Baffling Construction and Assembly

JBWeld:

Carbon fiber tube to Aluminum interface

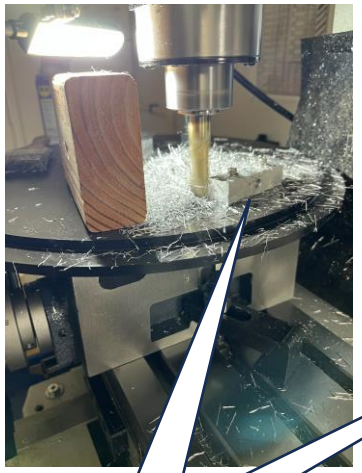
Baffle to corrector Plate

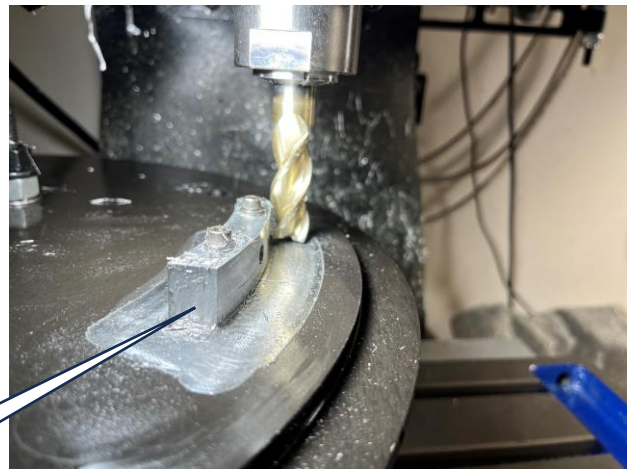
Carbon fiber tube
Aluminum interface



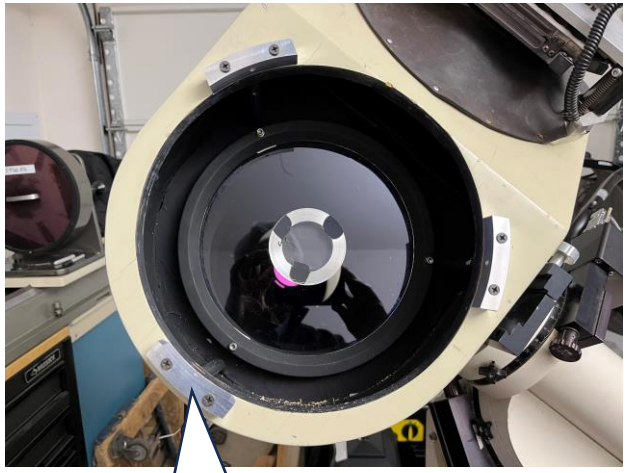
Corrector Plate

Dew Shield **Extending**





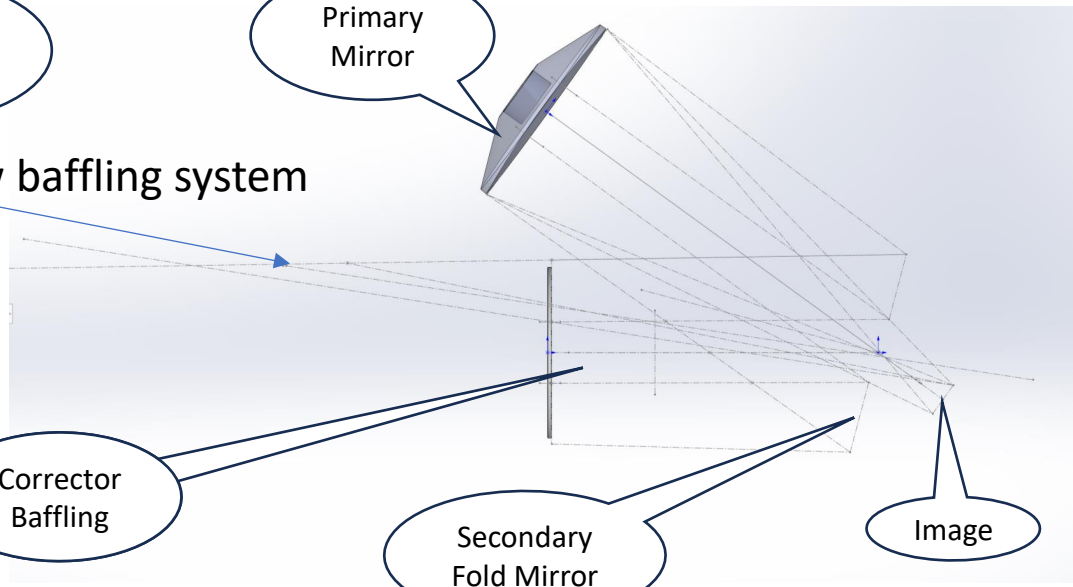
Milling
the Cleats



3-Cleats for
Dew Shield
Support

Dew Shield
In-Place

Dew Shield needs to be longer for stray light control under the new baffling system



Primary
Mirror

Conical
Light Trap

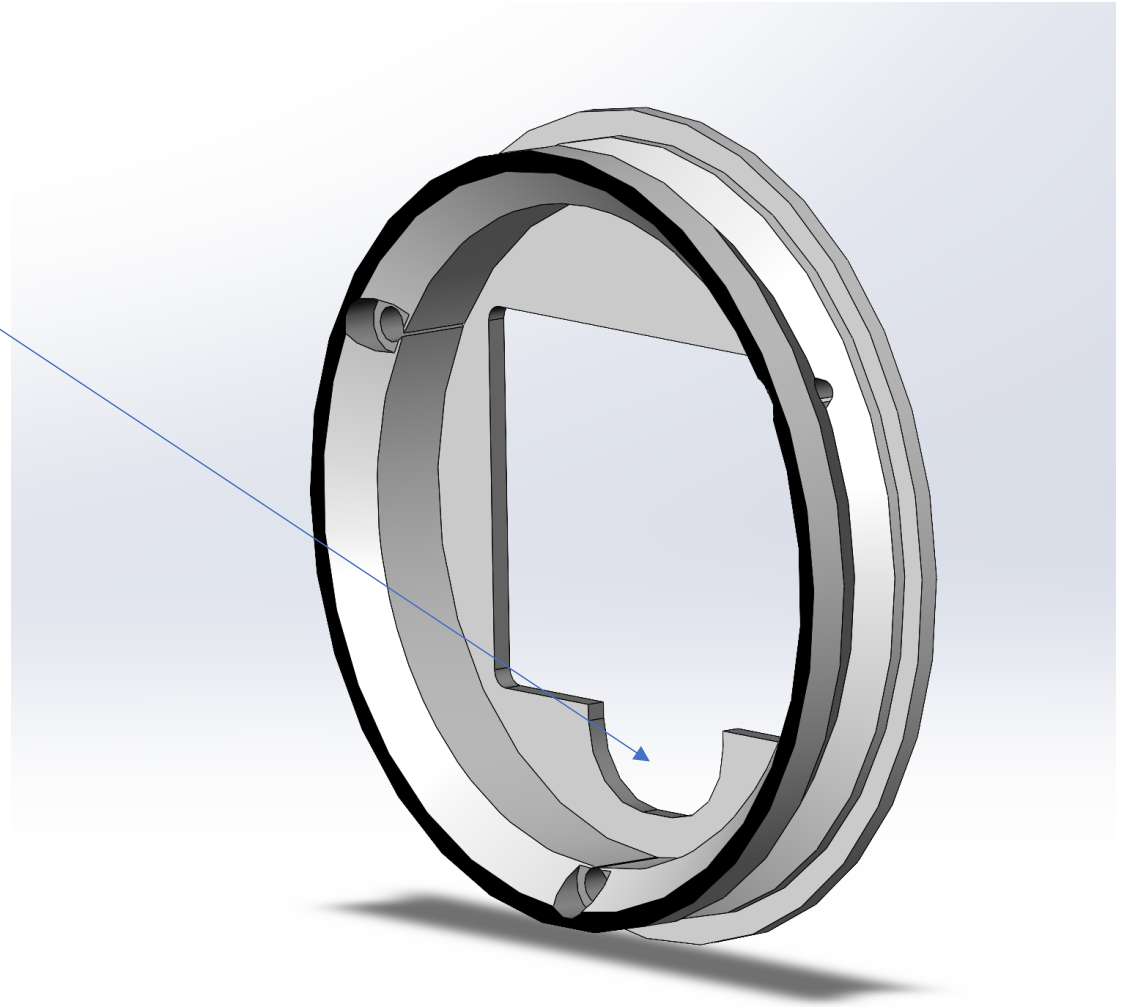
Corrector
Baffling

Secondary
Fold Mirror

Image

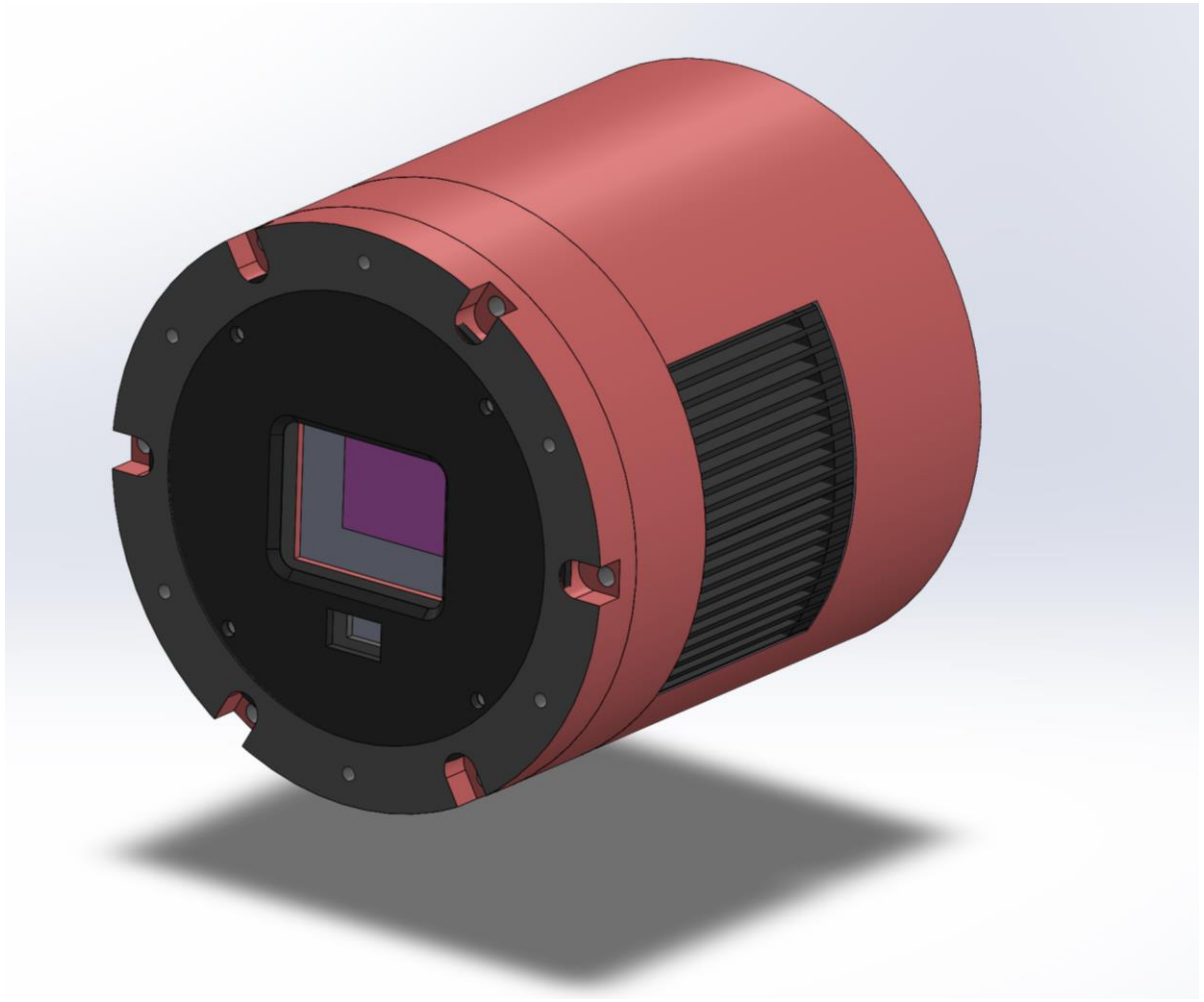
ASI2600Duo Camera Interface

Add cut out for Guider Optical Path



Remove Tilt Plate from the Camera

- 5mm thick tilt plate is not needed
- Reduced optical path is needed for correct spacing from rear Lens group to image plane
- AdditionalCamera considerations
  - 2mm thick Dewar window assume Bk7
  - And 0.5mm thick FPA optical cover assume Bk7
  - Total camera mechanical path 12.5mm

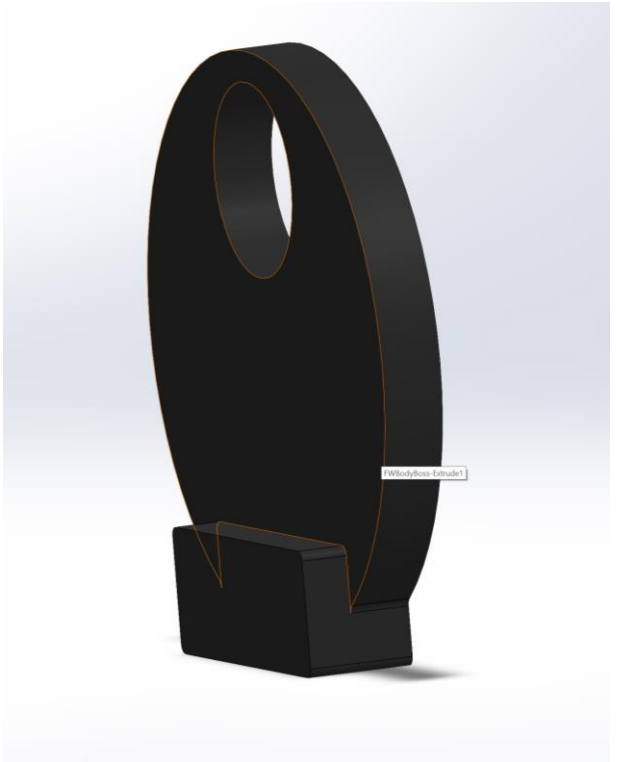


Reduce the Thickness of the Filter Wheel Body
(For Optimal Back Focus Spacing from Field Corrector to Image Plane)

From: 0.784” thick

To:0.665” thick

Necessary:
The Correct spacing
of 0.04” thick filters, from
Astronomik, of the original optical
design



Camera Assembly ASI2600Duo for 8.25” F/2.6 Astrograph

- Astrograph Interface
- Filter Wheel Modified-Thinned
- ASI2600Duo Camera

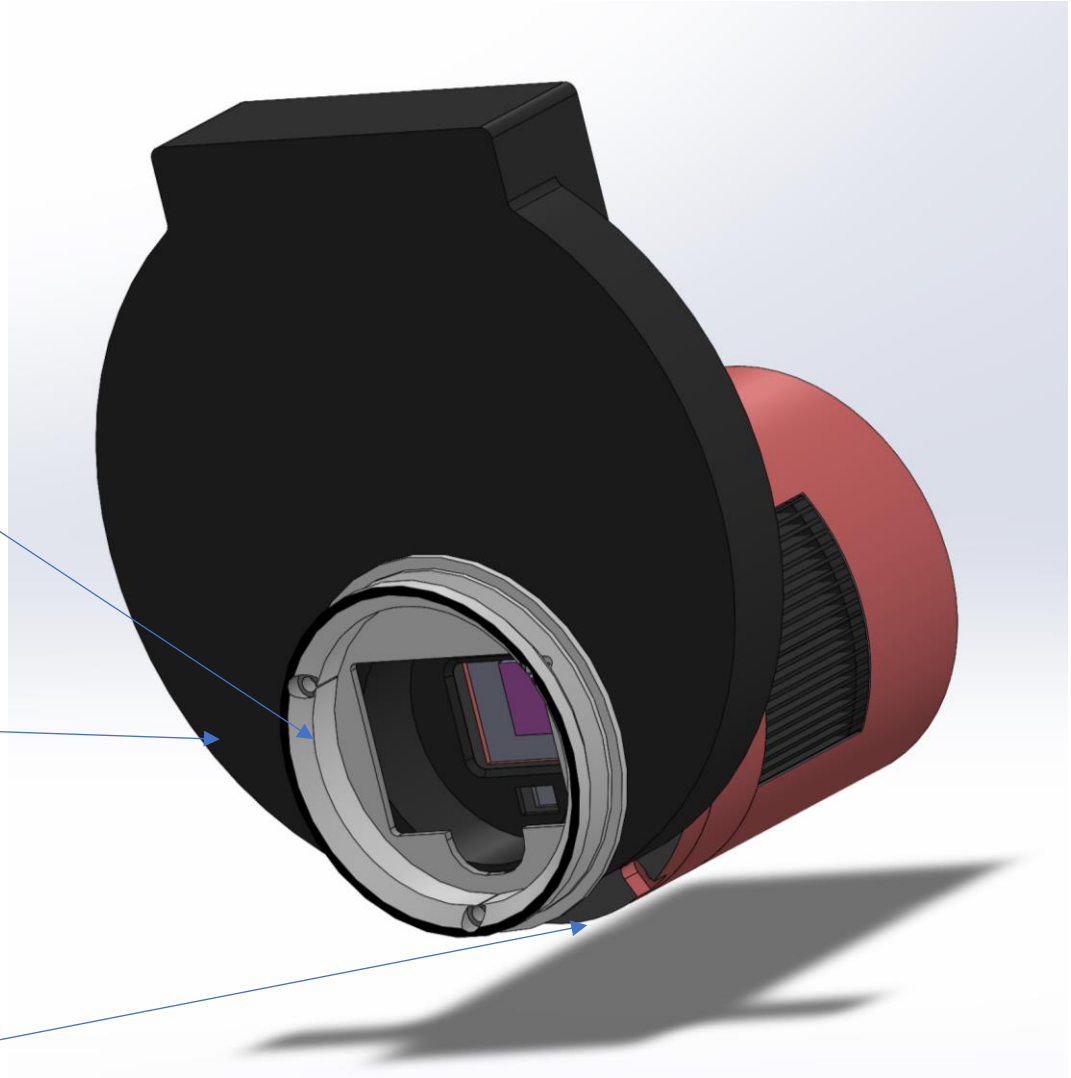
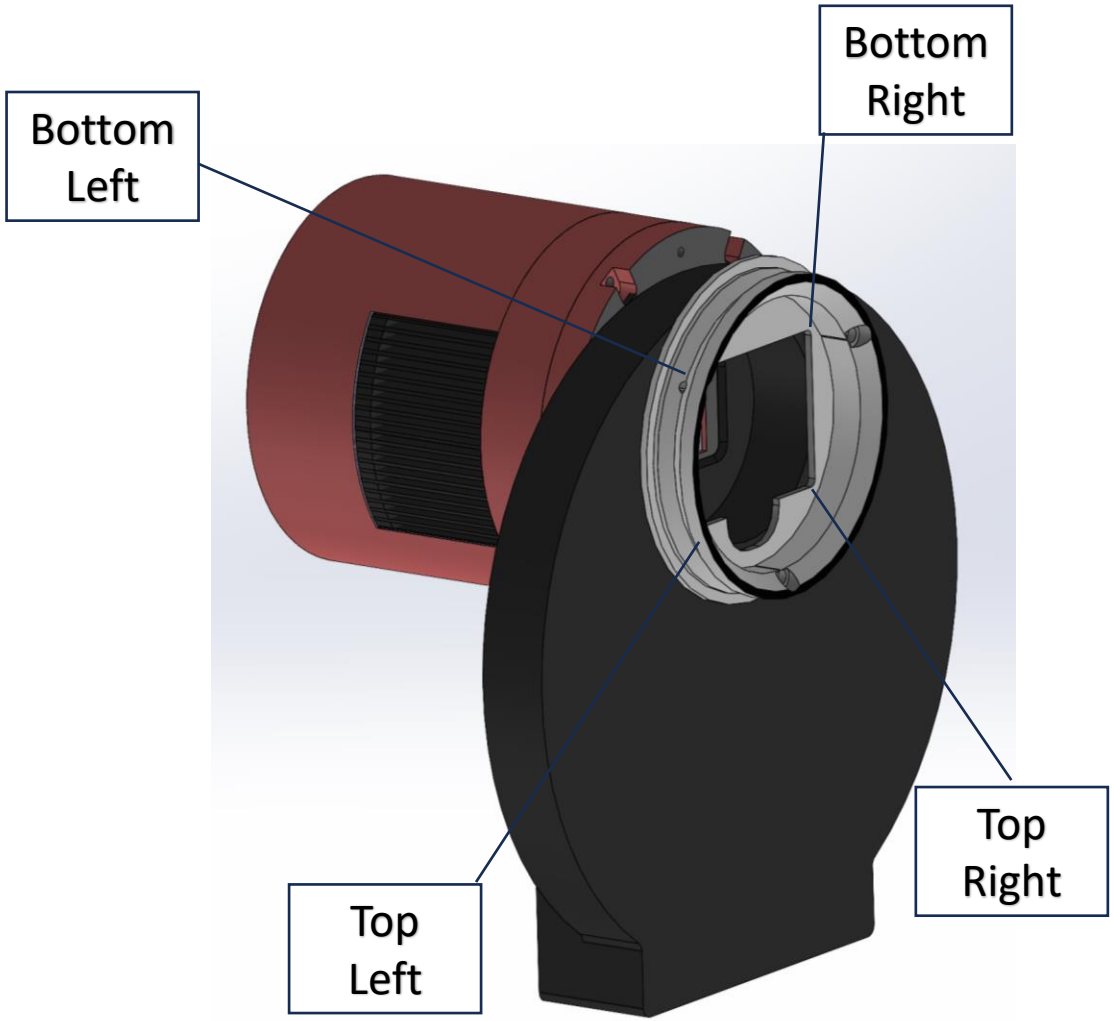
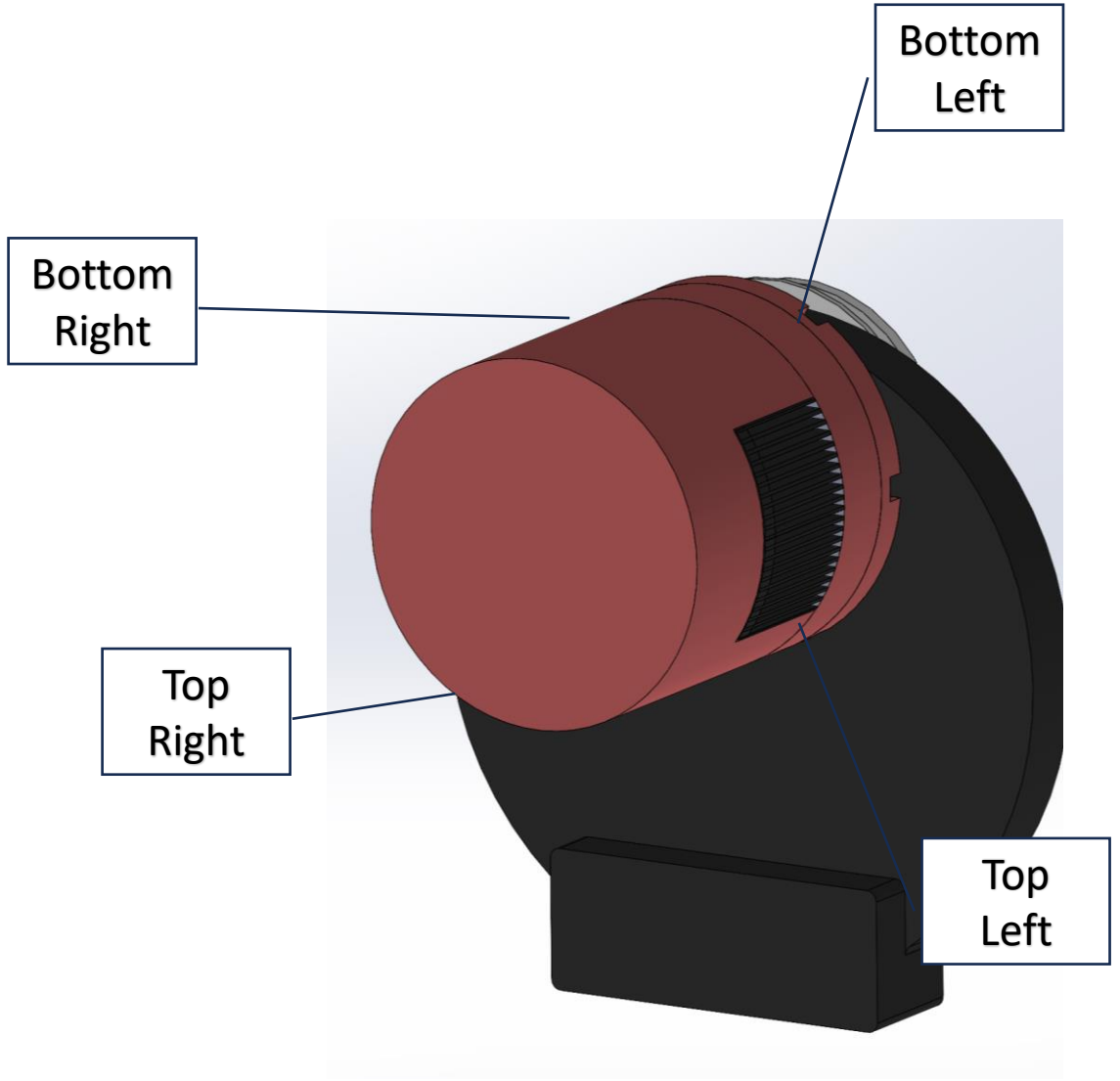
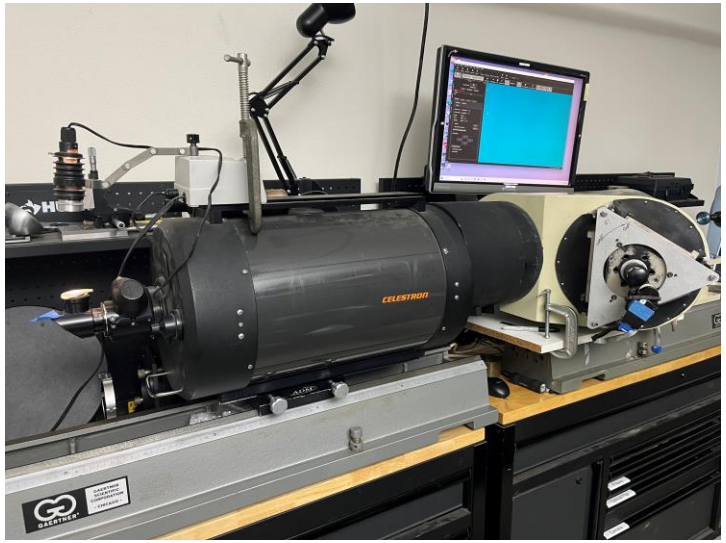


Image Position

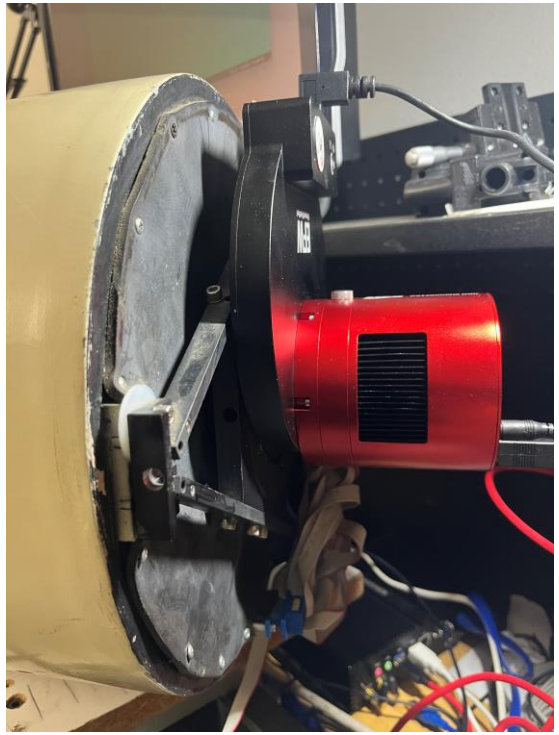




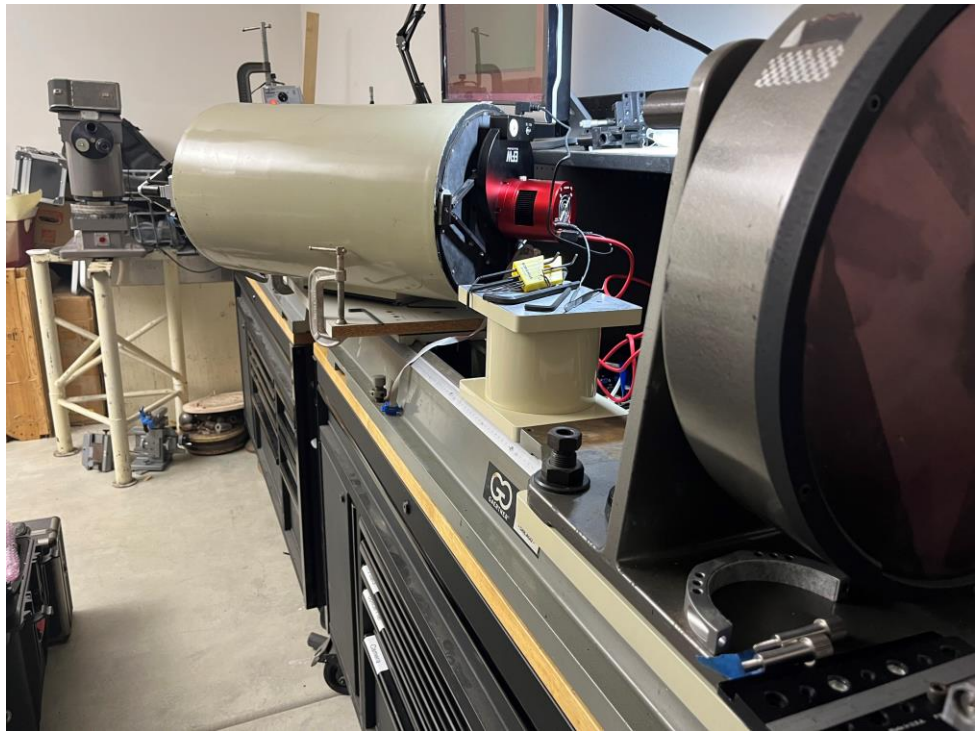
Assembly, Alignment and Testing Astrograph Upgrades in the Garage Shop



- C11-collimator and
- The F/2.6 Astrograph



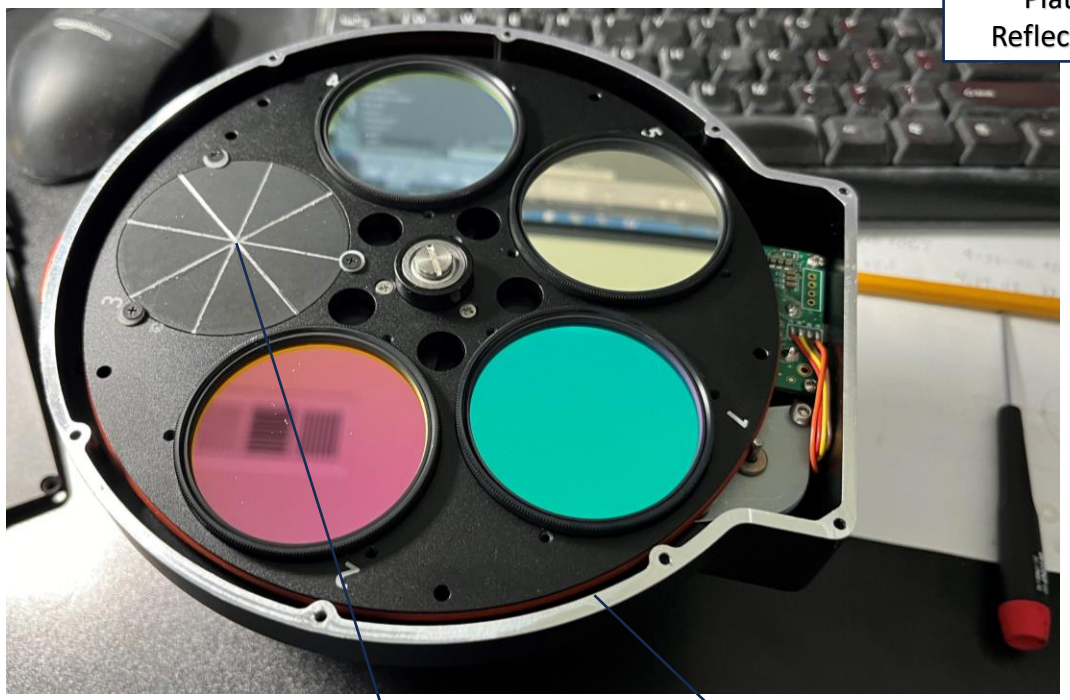
- Modified Camera Assembly

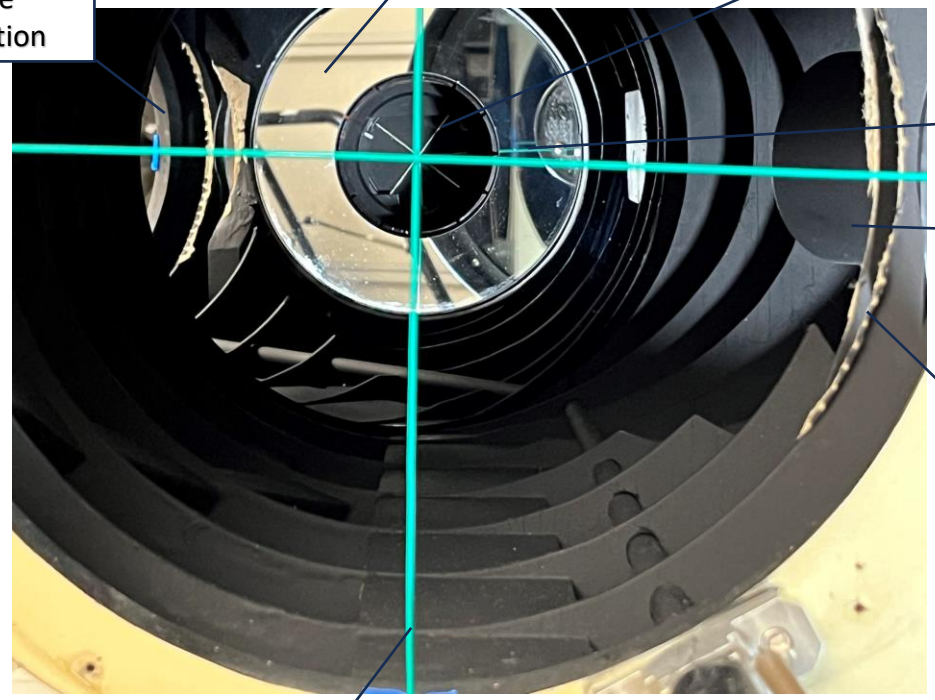


- The Test Bench

10” Fold Secondary Mirror Alignment

(View from Primary-Primary Mirror Removed)





Corrector Plate Reflection

Fold Mirror

Filter Cross

Fold Cross

Corrector Plate Baffle

Will Repair this removed Baffle

Filter Cross

Thinned Filter wheel Body

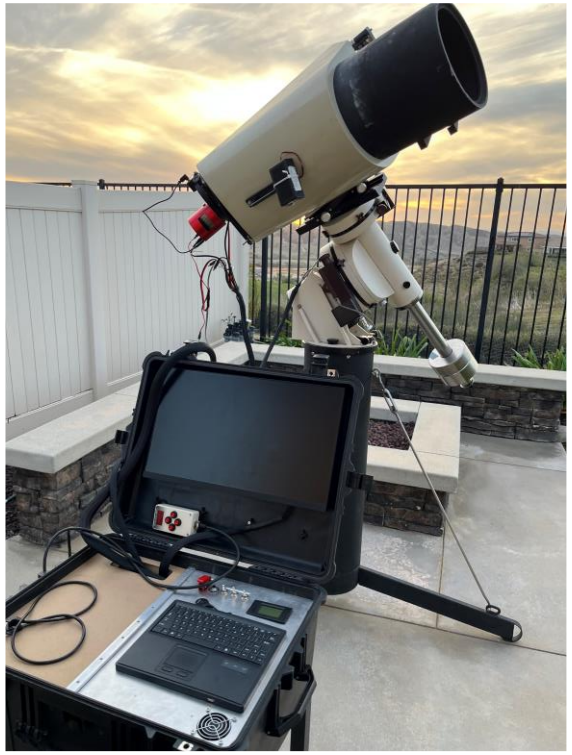
Primary Cross

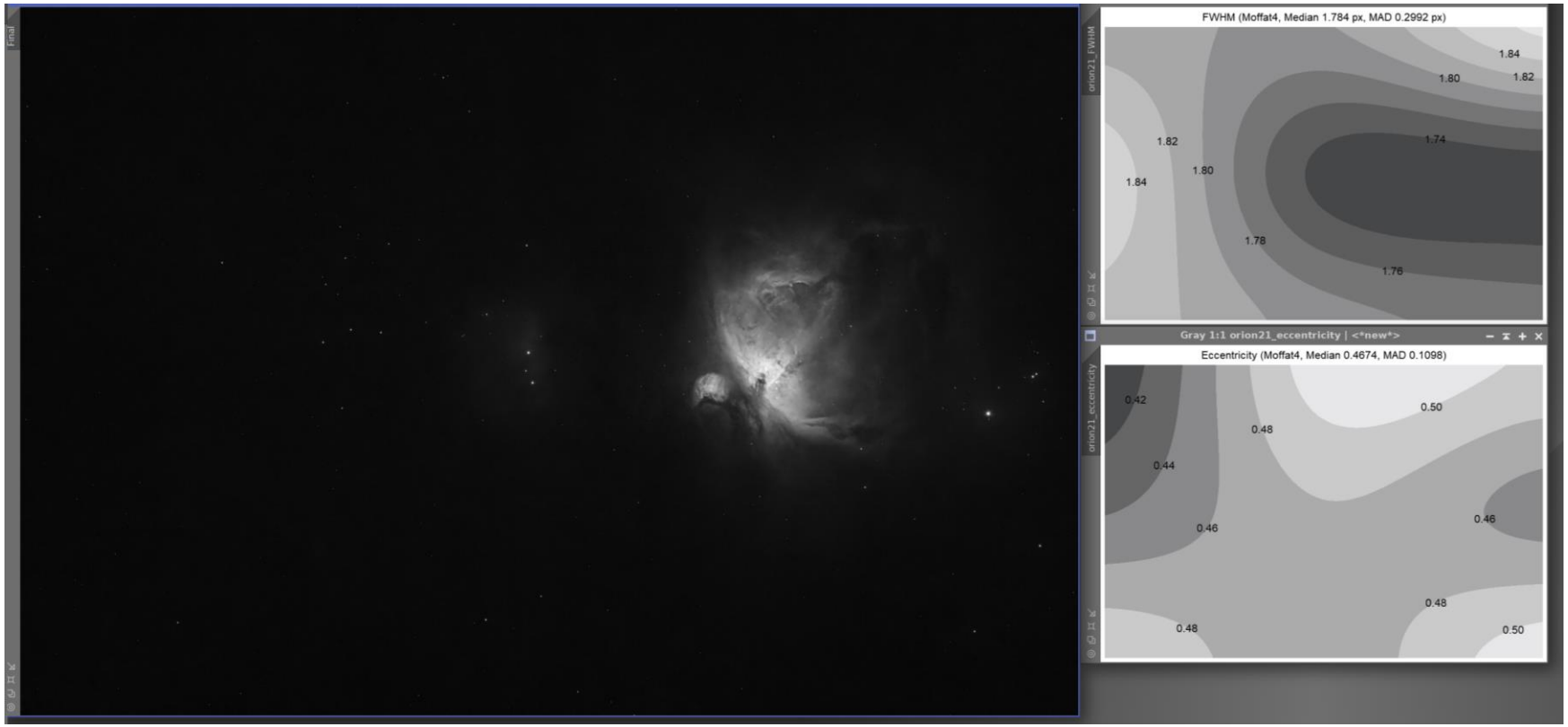
After fold mirror alignment above:

1. Align primary mirror by “centering the donut”
   - Inside focus
   - Outside focus
2. Remove any camera tilt by balancing the star images at the corners with the field center. Use brass shims for final tilt adjustment

First Light on a Bad Night March 4, 2025

- 4.05” exposure
- 12nm Halpha (Astronomik)
- Intermittent Clouds





Processed Image Above is a Single Frame (BX processed)
1.74-1.84 Pixel (FWHM)
0.42-0.5 Eccentricity

First Light on a Bad Night

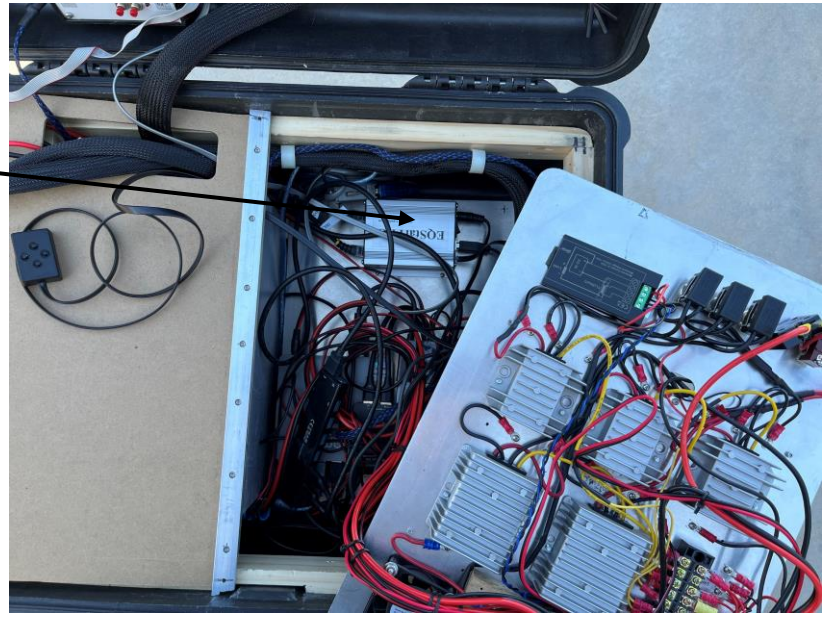
12nm Halpha Filter

ASI2600mm Duo: ST4 not supported… Pulse Guiding Needed

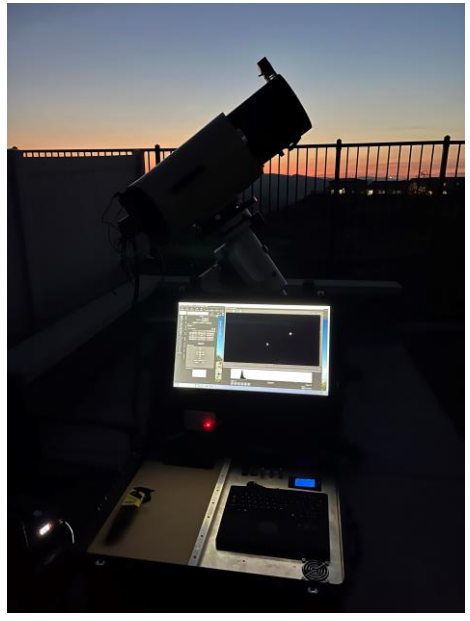
(Mods to Traveler Setup Needed for Backyard Tests)

- ASI2600 Duo does not have ST4 guider compatibility.
- FS2 drive controller needs ST4 guider data for autoguiding.
- Replace the Old FS2 with a new Astrogadget EQStarPRO drive controller with pulse guiding support.

Traveler-Field Setup (Mods)



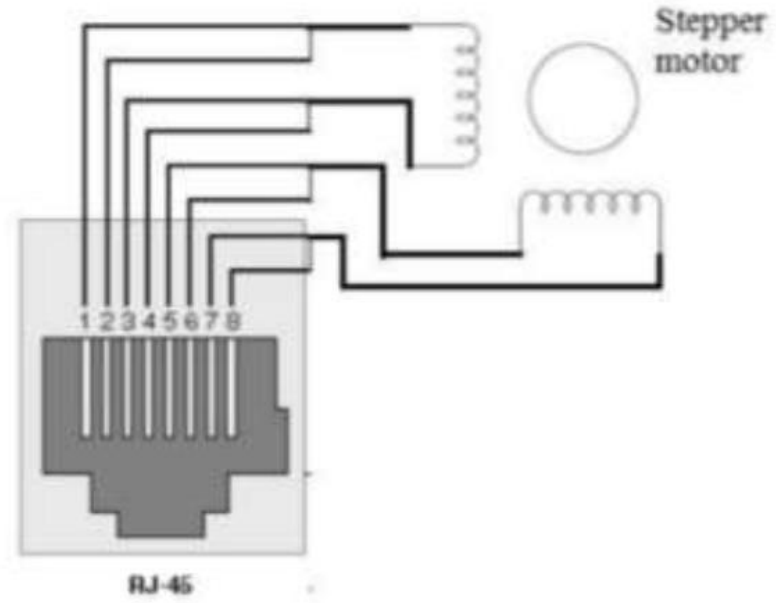
Traveler-Field Setup
Under the Stars

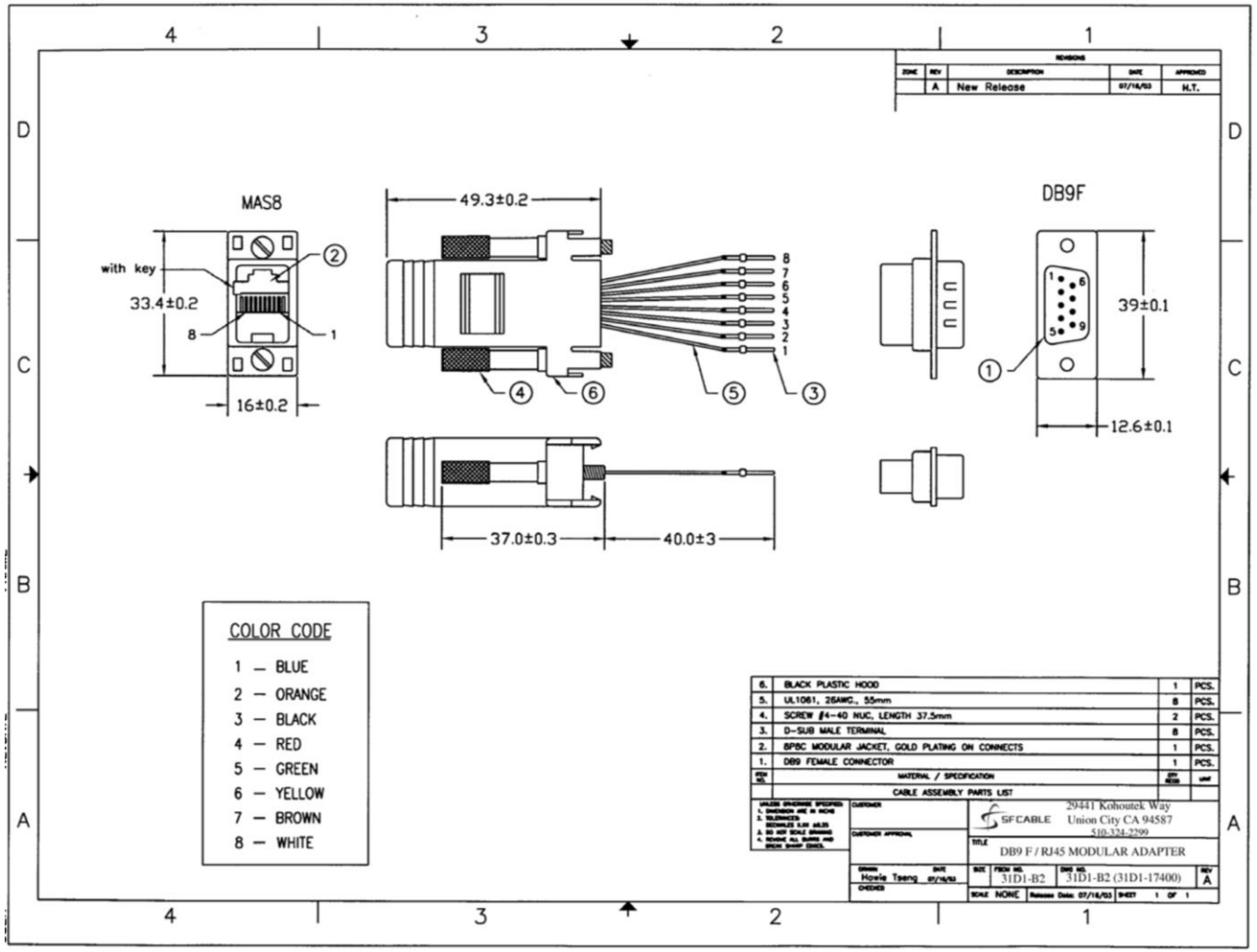


AstroGadget EQStarPro Drive Controller

(For the Traveler Backyard Setup)

- DB9 to RJ45, for stepper wiring.

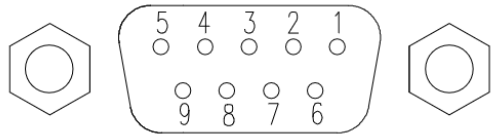




FS2 Astroelectrik Drive controller (the old one)
Wiring to new controller RJ45 to DB9
(Keep the Old Steppers from the FS2)

- DB9 pins
  - Pin 1 = Blue
  - Pin2 = Black
  - Pin4 = Green
  - Pin5 = Brown

Pin Assignment of the FS2 motor jacks:

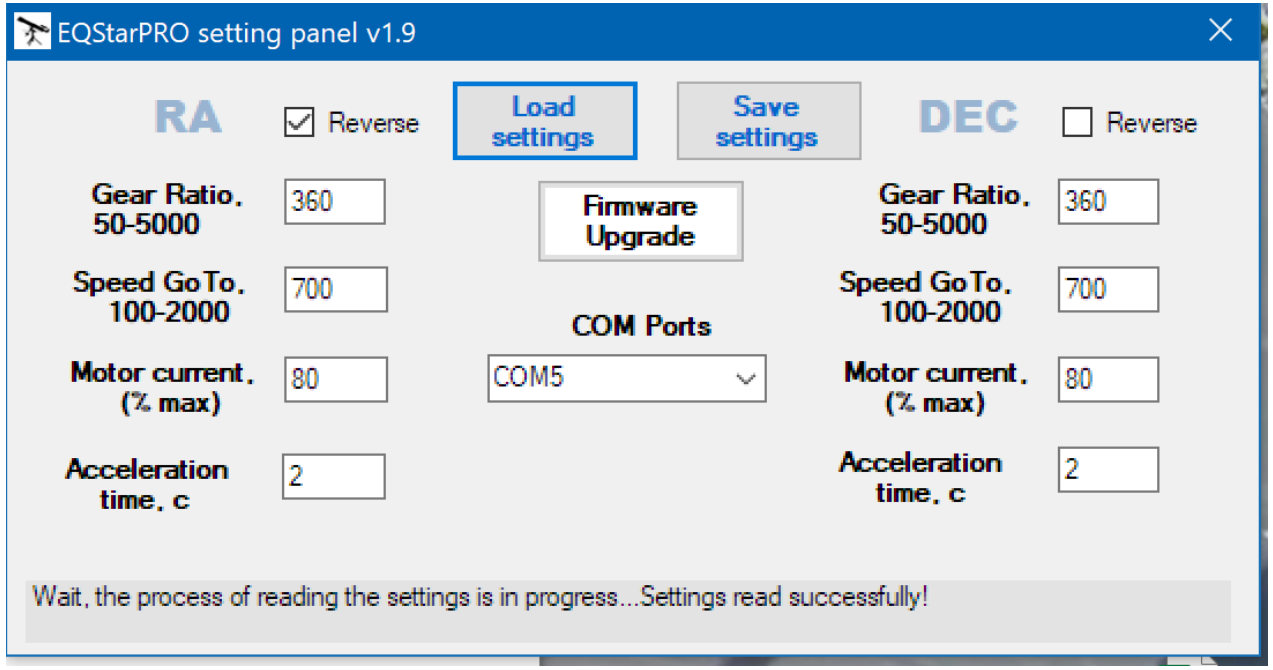


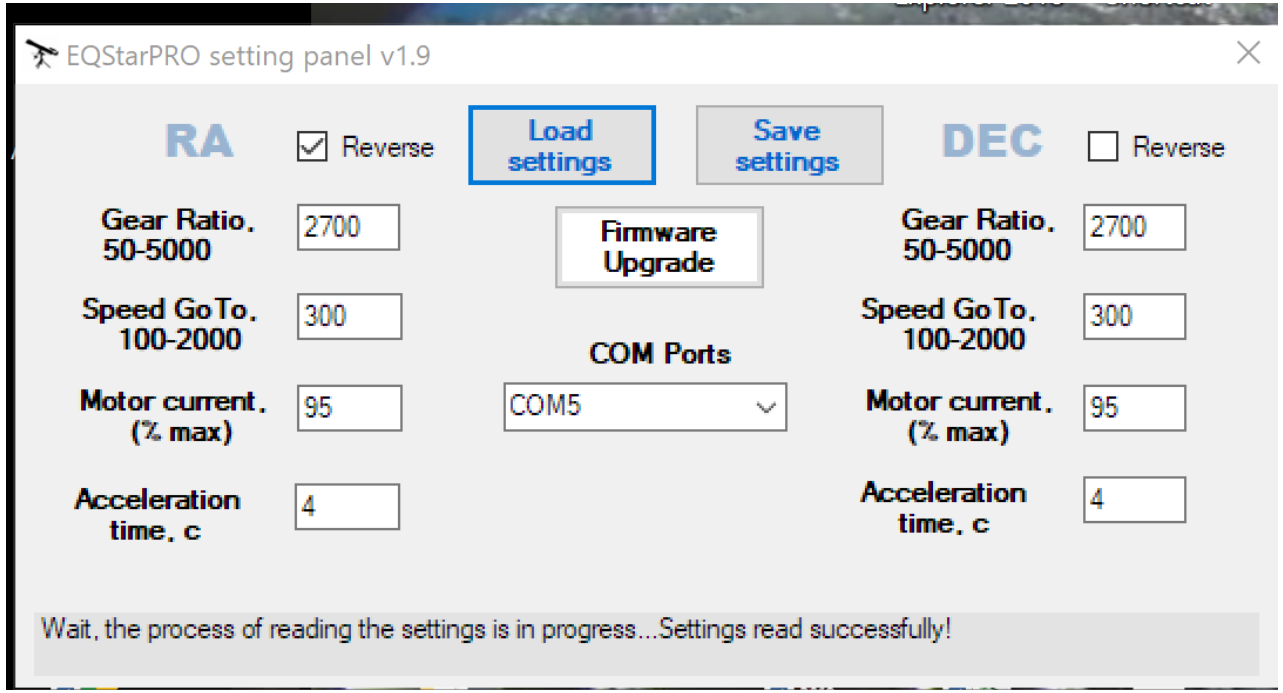
Pin 1	**Coil 1, beginning**
Pin 2	**Coil 1, end**
Pin 3	**Not connected**
Pin 4	**Coil 2, beginning**
Pin 5	**Coil 2, end**
Pin 6	**Ground (shielding)**
Pin 7	**Ground (shielding)**
Pin 8	**Ground (shielding)**
Pin 9	**Ground (shielding)**

The motor cables should not be longer than 3 meters, because otherwise the losses in the electronics will be high due to the high capacitance of the cable!

EQStarPRO As Delivered Losmandy Settings

- Test the “Gear Ratio” settings for AP1200
  - 2700 setting guides well
  - Still using the Astroelectrik steppers from the FS2 days





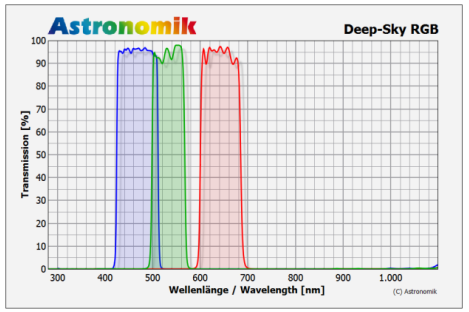
EQStarPRO AP1200 settings

DEC axis stalled with these settings. Ordered the EQStar POWER device. 20250322 4amps max to steppers…

FilterWheel

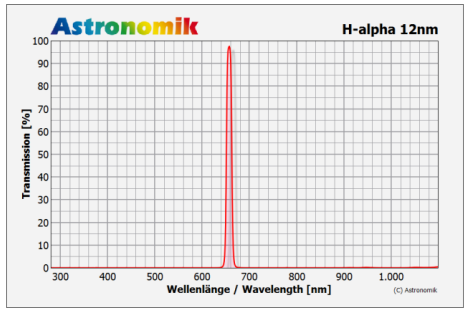
(Filter Offsets Testing)

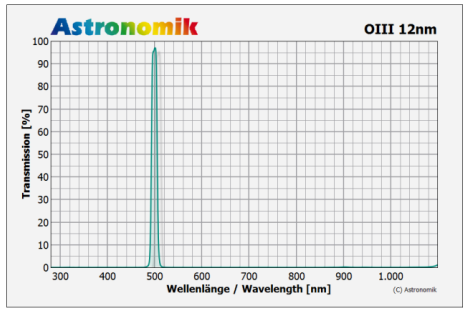
- R,G,B,Halpha, OIII mounted Astronomik
  - Deep Sky RGB 2” mounted
  - Halpha 12nm 2” mounted
  - OIII 12nm 2” mounted



- Focus: 10ticks=0.001” Depth of Focus ~0.0007”

Filter	Focuser Position Average Reading	Offset
R	428	0
G	428	0
B	425	-3
Halpha	402	-26
OIII	410	-18





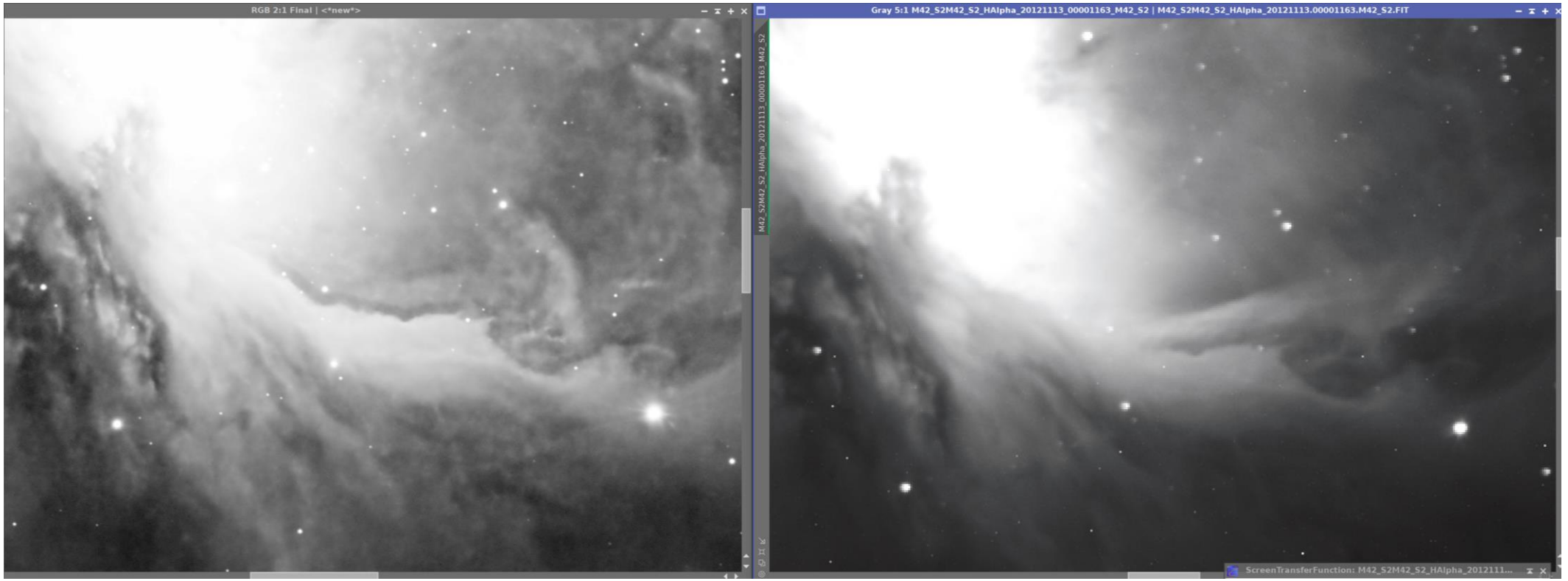
Bright Star Test 300sec Blue Filter, No Flat, No Dark

Bortle 5-6 Backyard

- Procyon 0.4 mag
- F5IV-V Spectral Type
- Good Performance and contrast, No visible Ghosts and Improved Diffraction Pattern

Improved Image Performance 2025 vs. 2012
(Single Frame Testing)

- CMOS camera 3.76 micron Pixels Bortle 5-6 No Flats No Darks 300sec -10C
- CCD camera 9 micron Pixels Bortle 1 Calibrated 720sec -2.5C

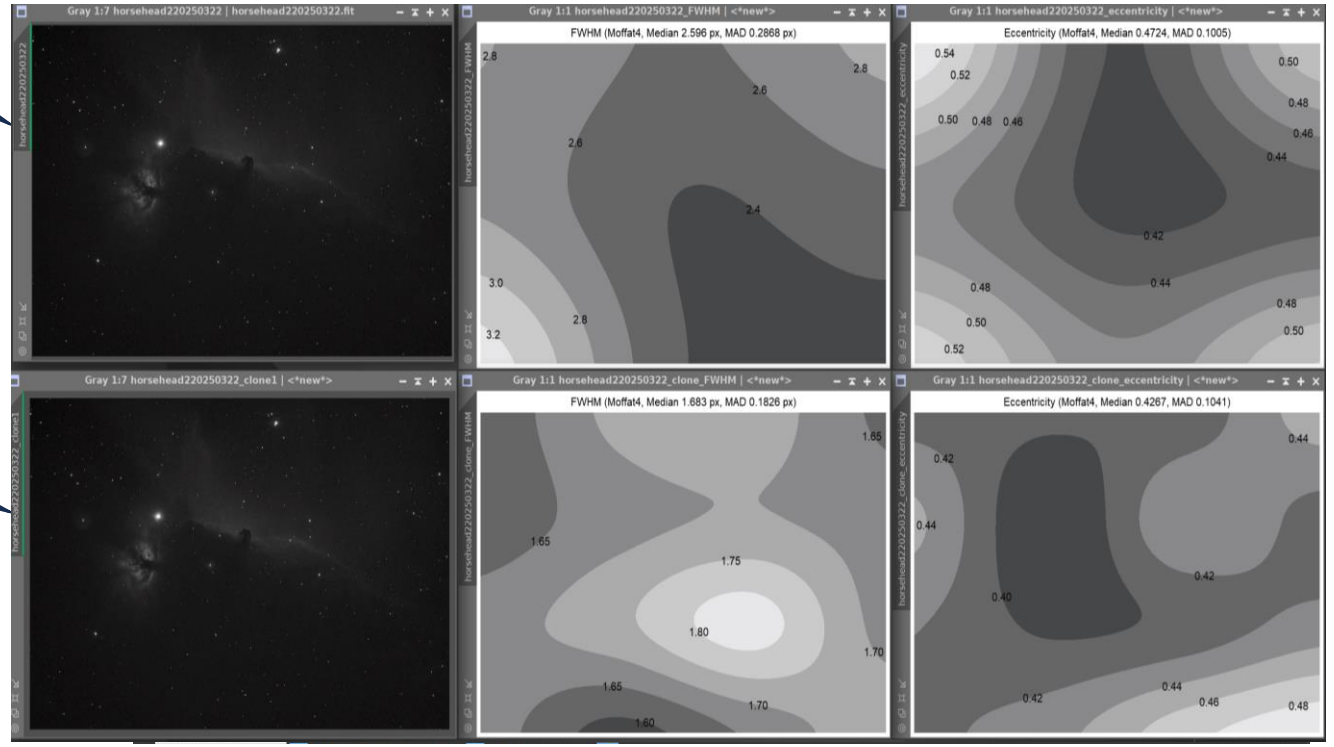


Refined Image Tilt Adjustments “Under The Stars”

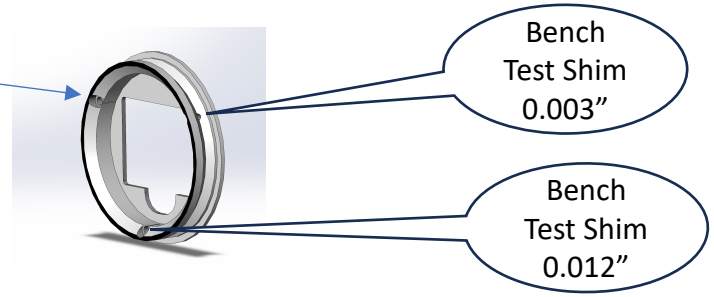
20250320-20250322 (12nm Halpha filter)

Raw Image

BX Processed Image



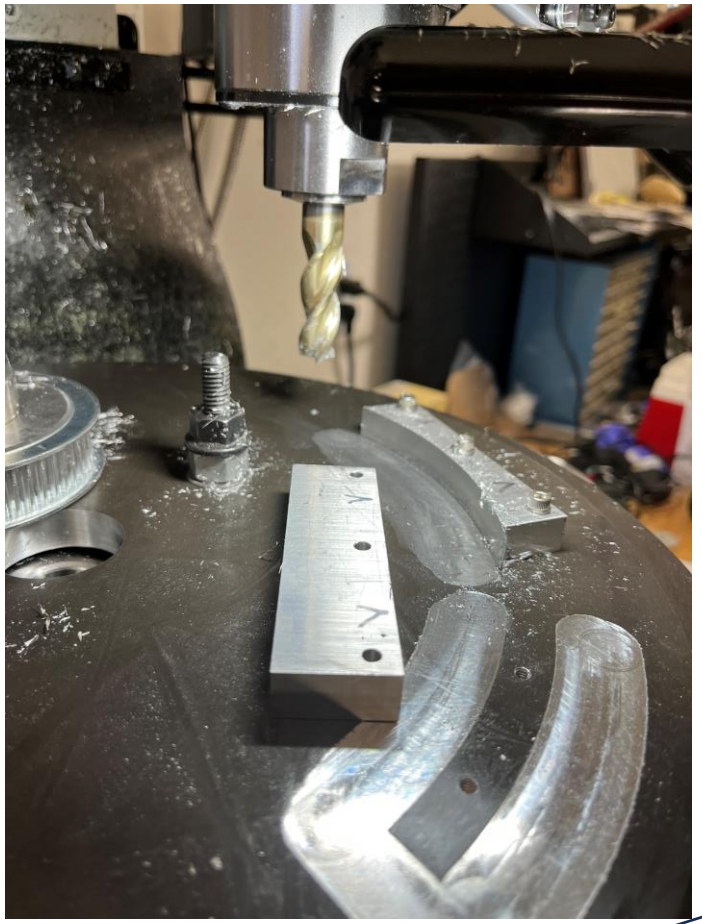
- Bench alignment is workable using BX very small error upper right to lower left 20 ticks of focuser ~0.002”. Recall, tilt +- 17 micron depth of focus using 4lF^2 to calculate. Will make a small adjustment to correct further.
- Cleaned the camera interface again and reseated the camera. No change in image tilt.
- Made a 0.001” shim adjustment 20250322 evening under stars. Improved field balance, and completes the tilt adjustments.
- The astrograph is image-ready for fielding!!

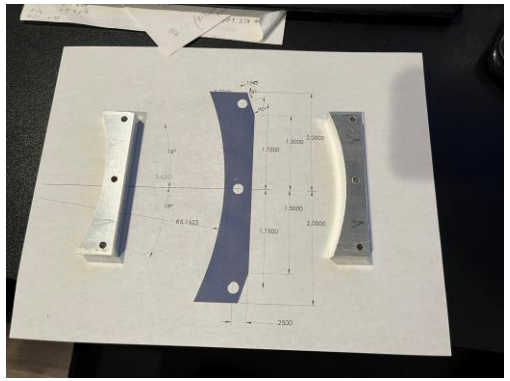


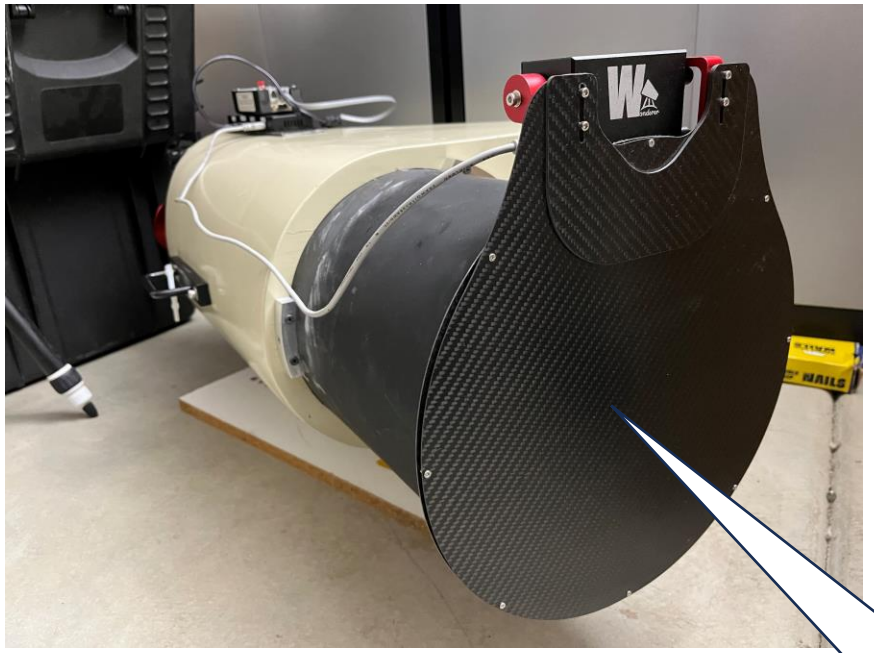
Single 120 second exposure, No Dark, No Flat Bortle 5-6 Backyard March 23, 2025

12nm Halpha Filter

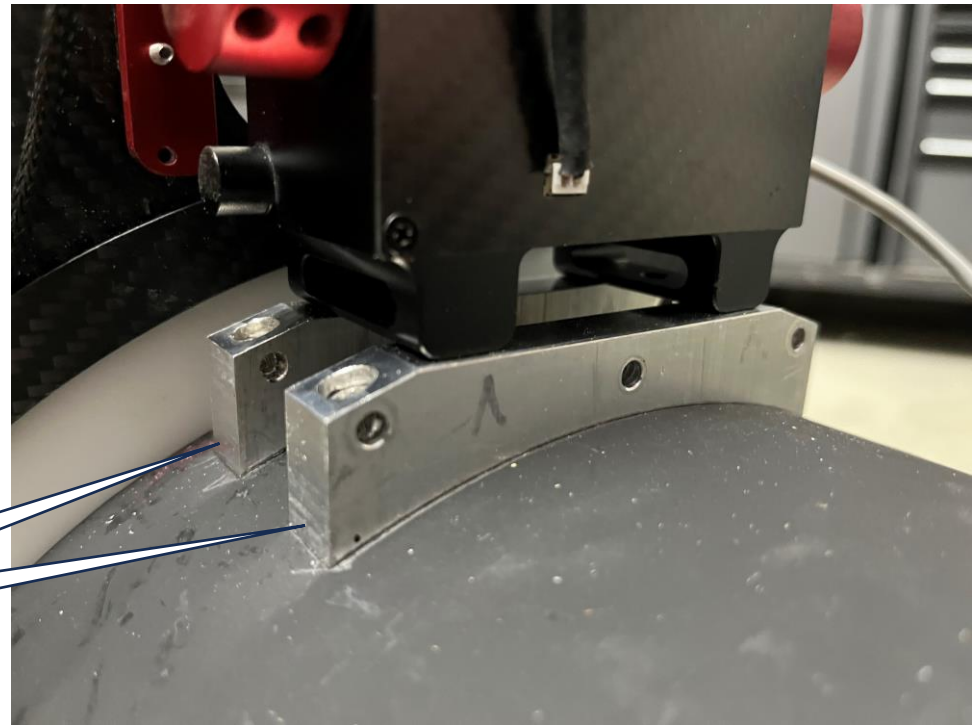
Flip Flat Cover







Wanderer V3
280mm

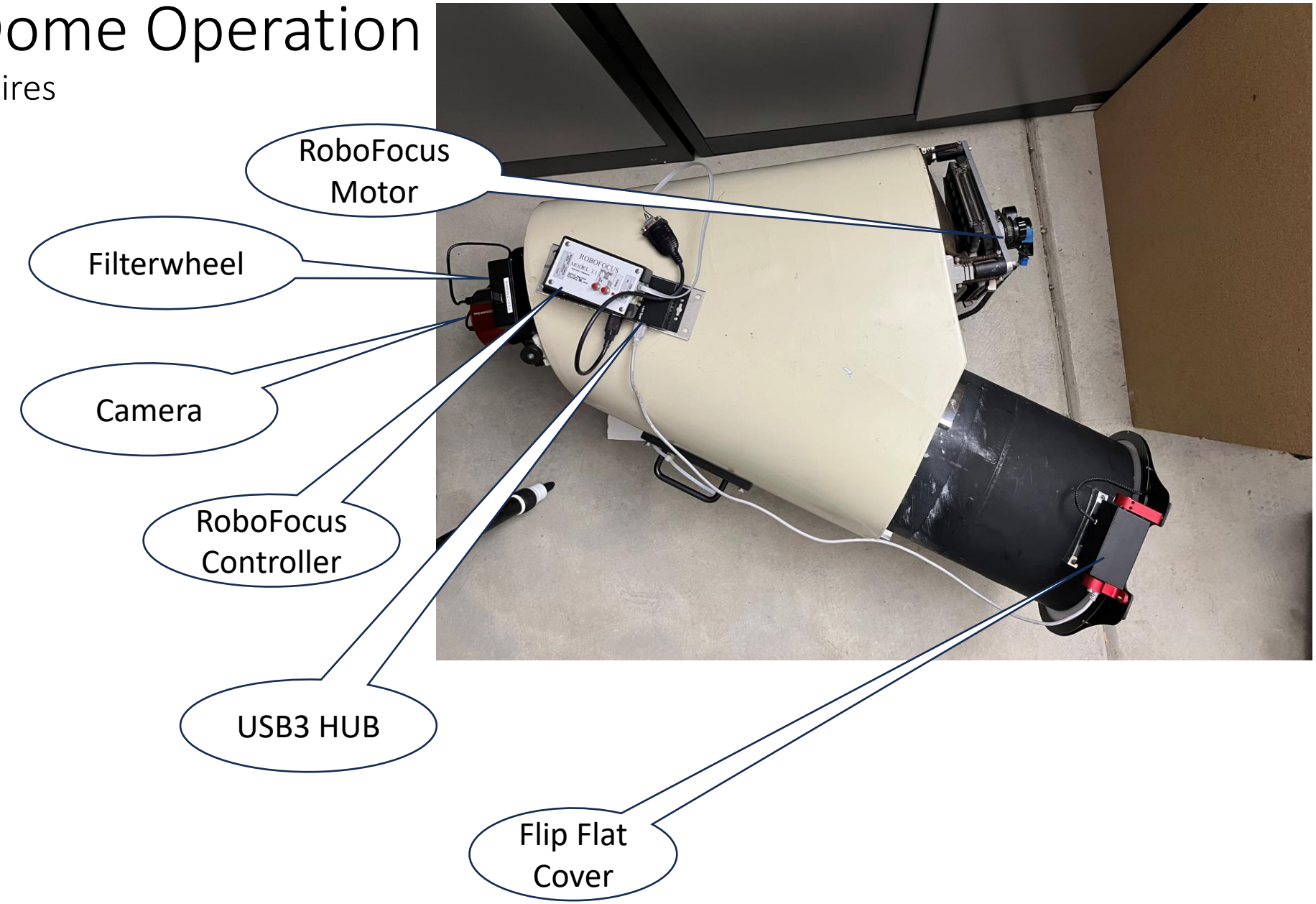


Holding
Cleats

The stand alone dome flat will be replaced by a Wanderer V3 280mm Flat panel Cover

Wiring the Scope for Remote Dome Operation

Components needing wires



In the Dome Cabling

Imager cable to interface box 4-cables 10’ long

1. USB3- for camera
2. 12volt power for camera 2.1mm center positive

3. USB3- for Hub
   - Cover
   - Focuser
   - Guider
   - Filterwheel
4. 12volt power for
   - Hub 2.1mm center positive
   - Focuser 2.1mm center positive
   - Cover 2.1mm center positive

Top Panel	
	Mount USB
	Mount Power
	Camera USB
	Camera cooler Power
	Focuser RS232
	Focuser Power
	Dome RS232
	Dome Power

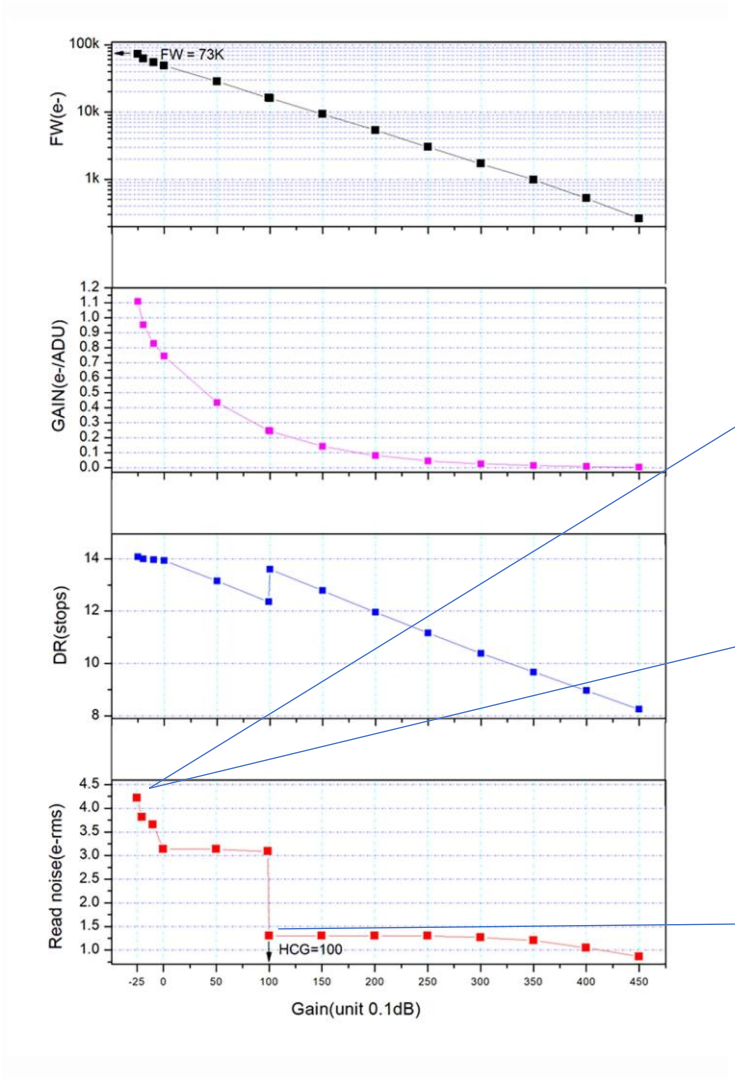
Power

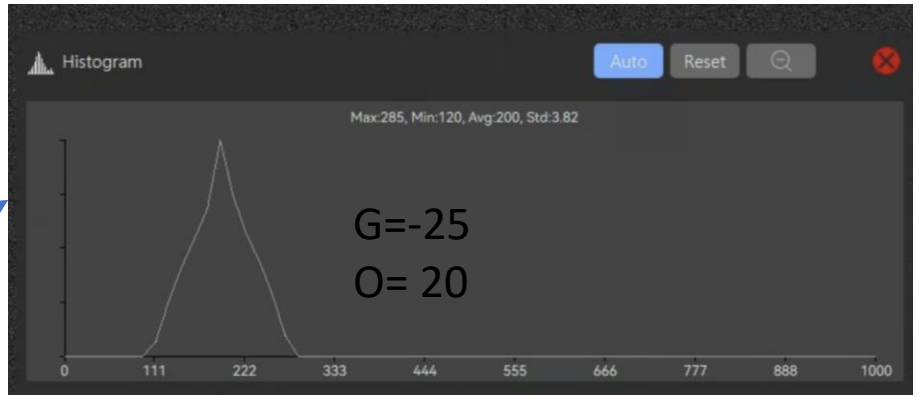
Pin 1=Black Negative

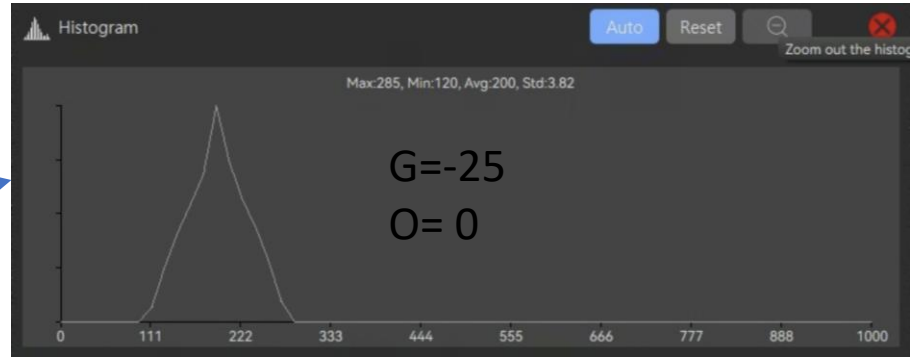
Pin 2= Red Positive

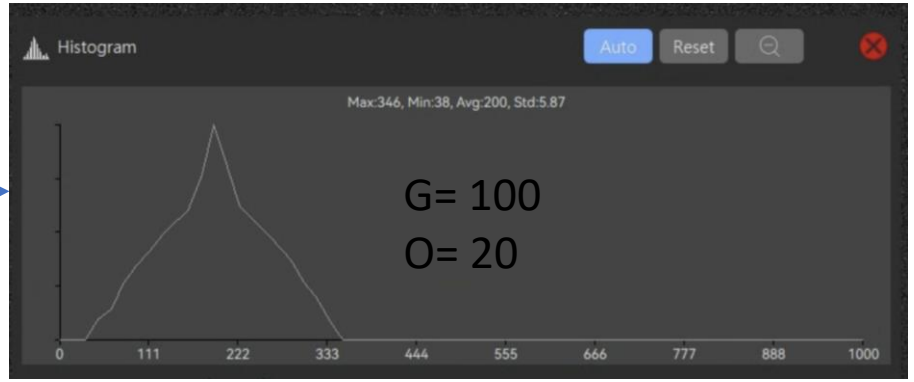
Gain-Offset Settings Determination Using Bias Frame Histogram

-10°C

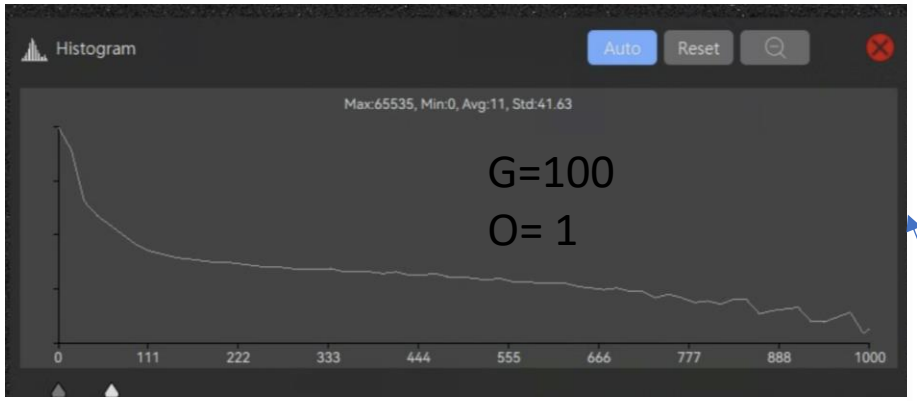


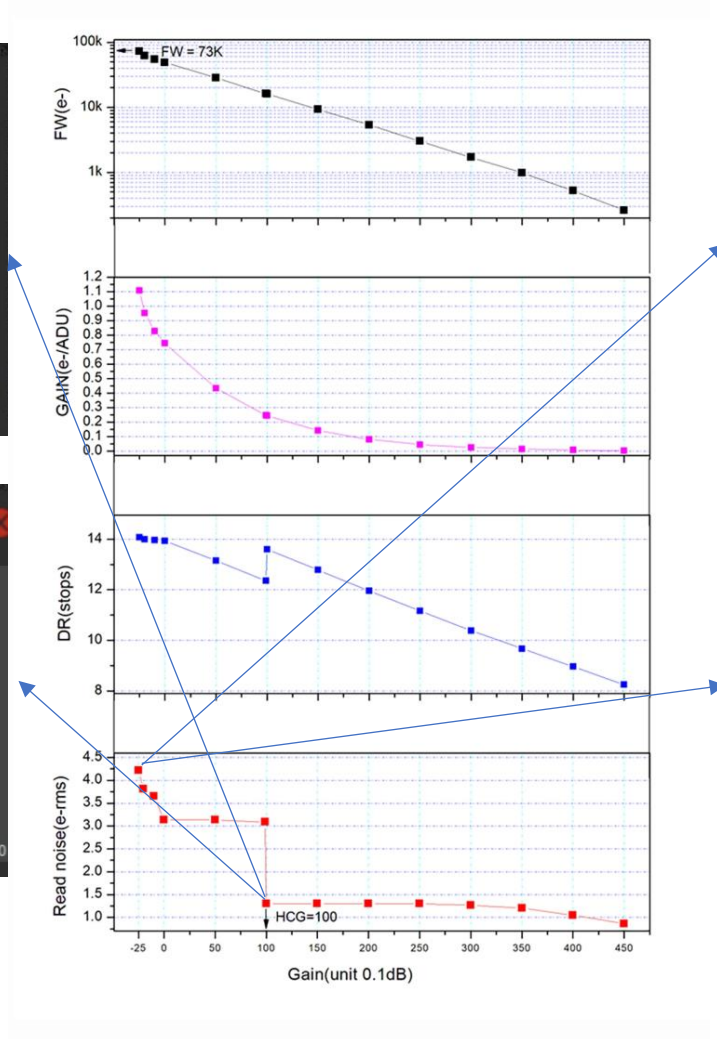


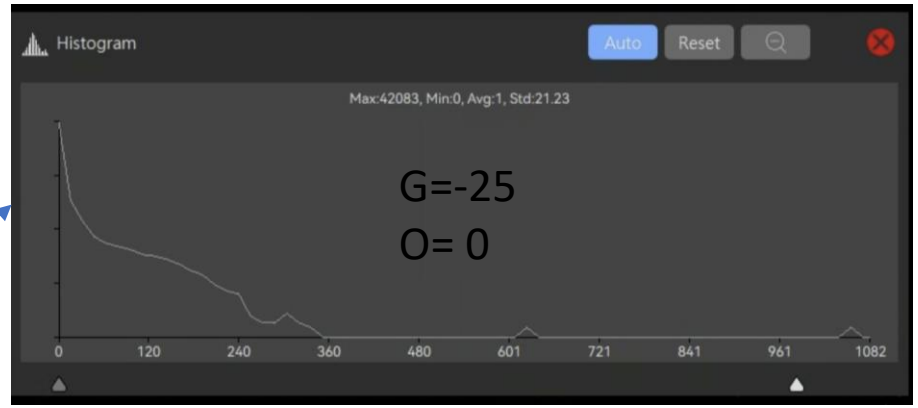


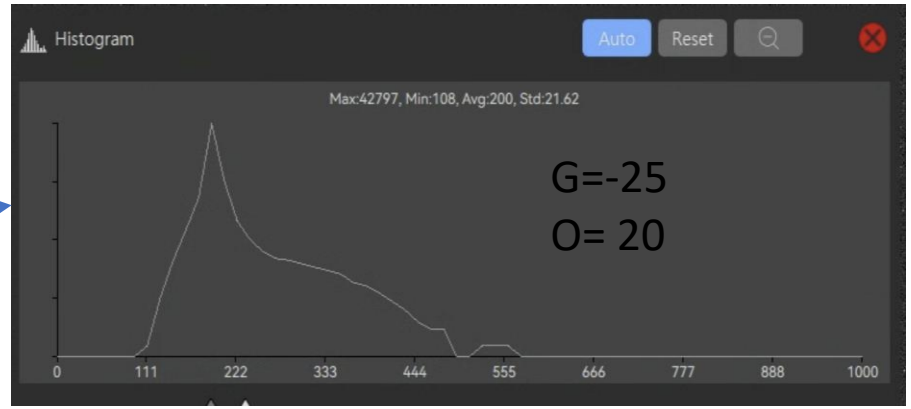


-10°C 600 Seconds Dark Integration Histograms





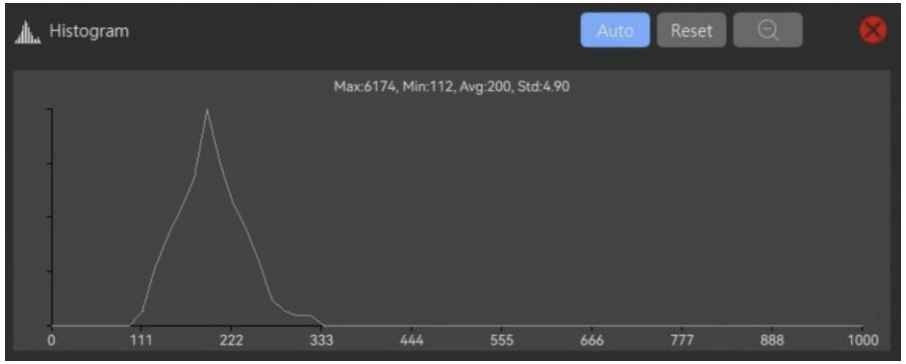




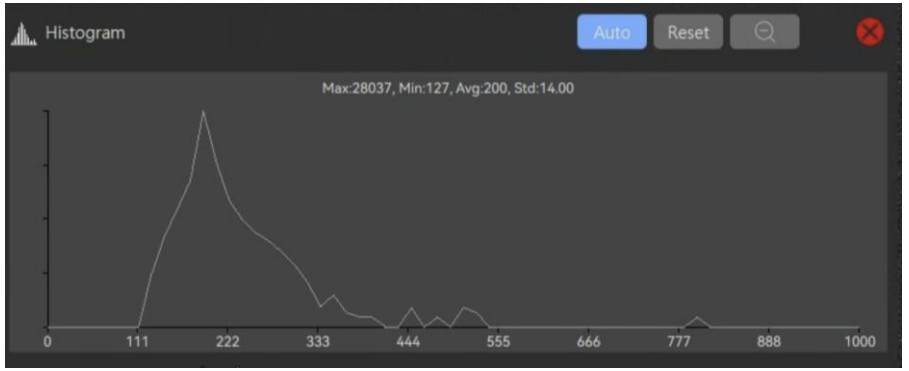
Will use -10°C Gain=100, Offset=20

-10°C Dark Integration Histograms (Single Frame)

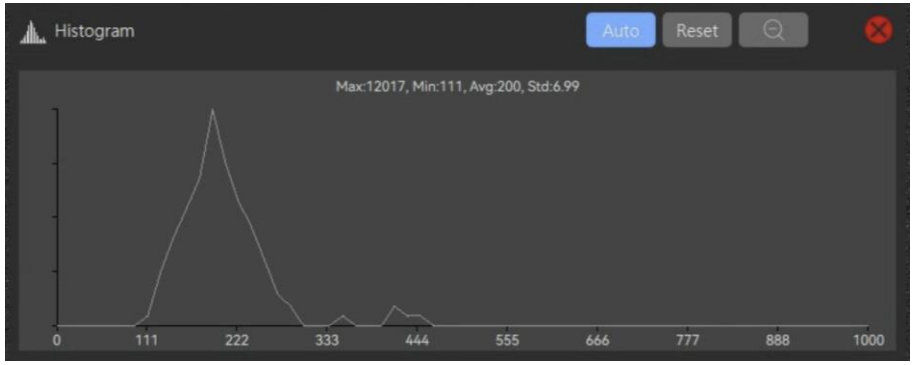
Gain=-25
Offset=20



60 sec

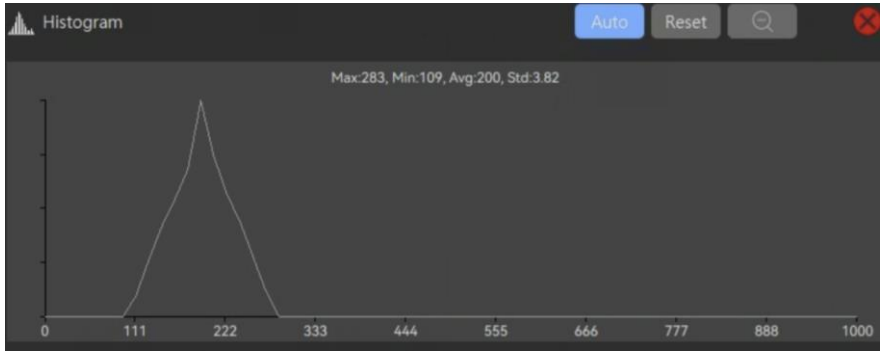


300 sec

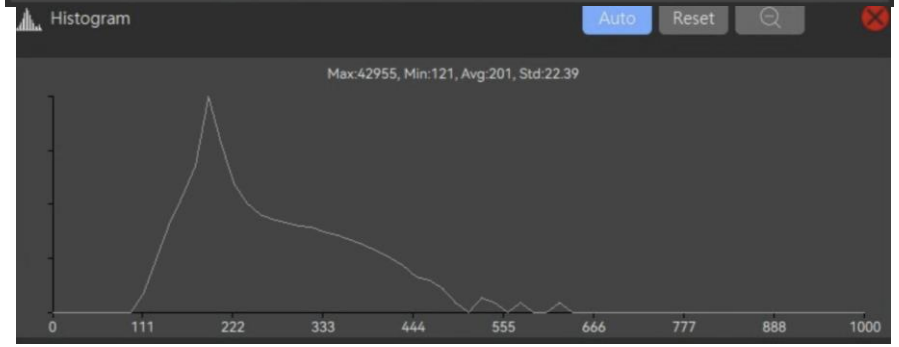


120 sec

600 sec
First



Bias

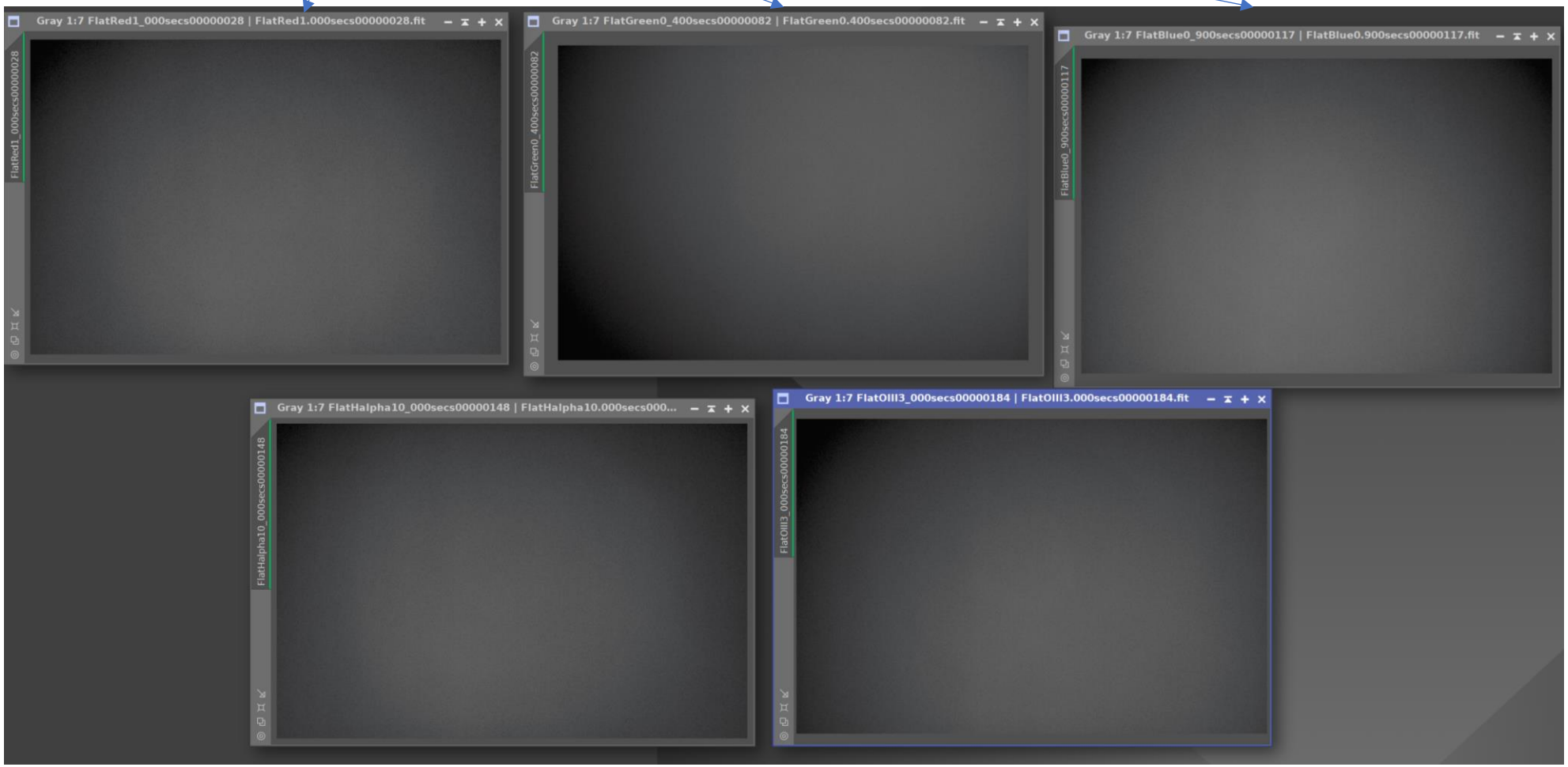


600 sec
Last

Flat Frames R, G, B, Halpha, OIII March 27, 2025

32 each: Using an EL Flat Panel

R= 1 sec
G= 0.4 sec
B= 0.9 sec
Ha= 10.0 sec
OIII= 3.0 sec



Halpha

OIII

Burn In Failures

Wanderer 280mm Flat pro panel:

The stepper driver for opening and closing… smoked!!

- Will replace with home made driver using an Arduino Nano
- Flat panel has issues with non uniform illumination, will replace with an EL panel.

Will build my own based on EL panel, porch swing style cover for minimal height during actuation.

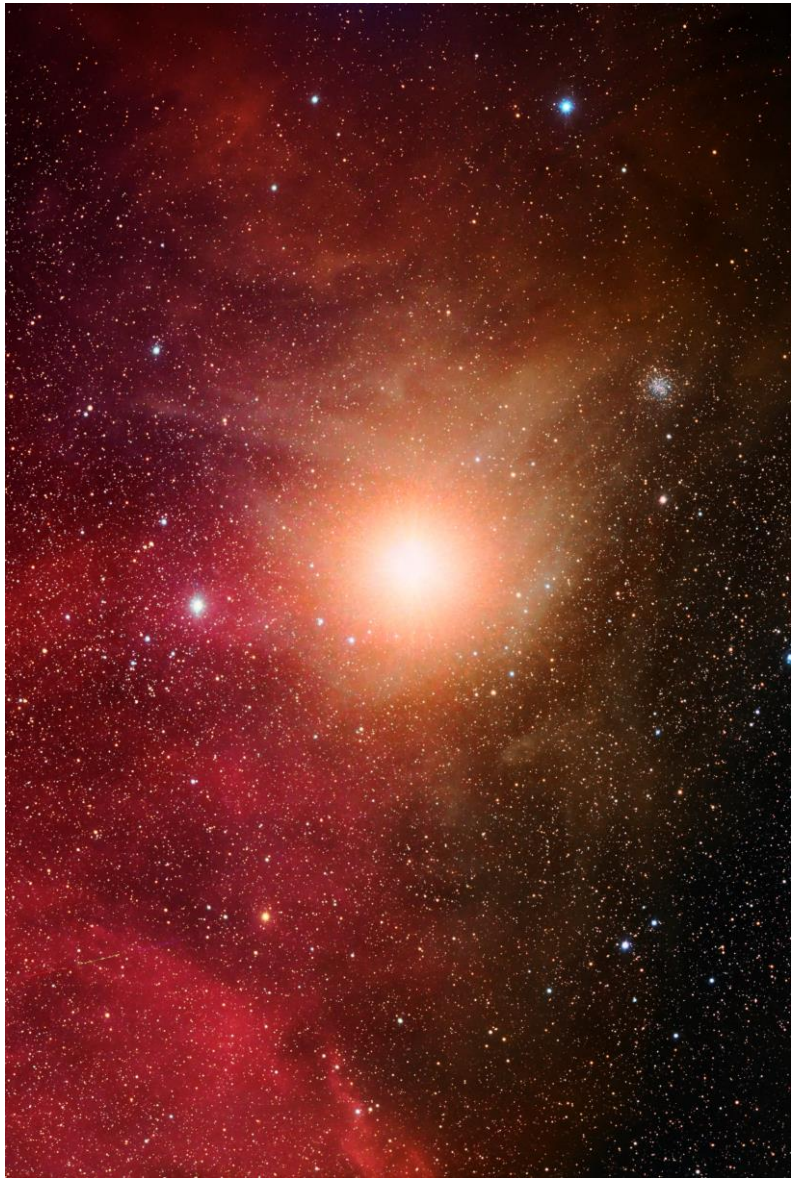
Installed in the Dome March 29, 2025

Clouded over just prior to sunset and didn’t clear till sunrise…
March 30, 2025 Clear early evening: Testing complete astrograph works as expected

Some Final Adjustments and an Image March 30, 2025

(1) Red 120 seconds
(1) Green 120 seconds
(1) Blue 120 seconds
(1) Halpha 600 seconds

Camera gain=101, offset=20



March 30, 2025:
Went up to the observatory March 29,2025 and installed the 8"F/2.6 in the 6' dome. It was clear and pleasant all day for the install. Mike joined me and we had steak and lobster at the local hangout, Grumpy Bears. During dinner near sunset the clouds rolled in. By astronomical twilight the skuy was covered in clouds and not a star in sight...

I had to wait till Sunday, the following evening, to complete the install, mount calibration, etc by remote control from home. I chose Antares because it is a very bright star low on the horizon with reflection and emission nebula in a dense star field. A good test of system contrast and ghosts.