OCA AstroImagers SIG

My Journey to Remote Observing
Part II
After Install Update

David Pearson
November 2019

Deep Sky West, Glorietta Mesa near Rowe, NM

Alpha building (on left)

- Phase 1: 2008 - 9 piers
- Phase 2: 2015 - 18 piers & scopes)

Beta building (on right)

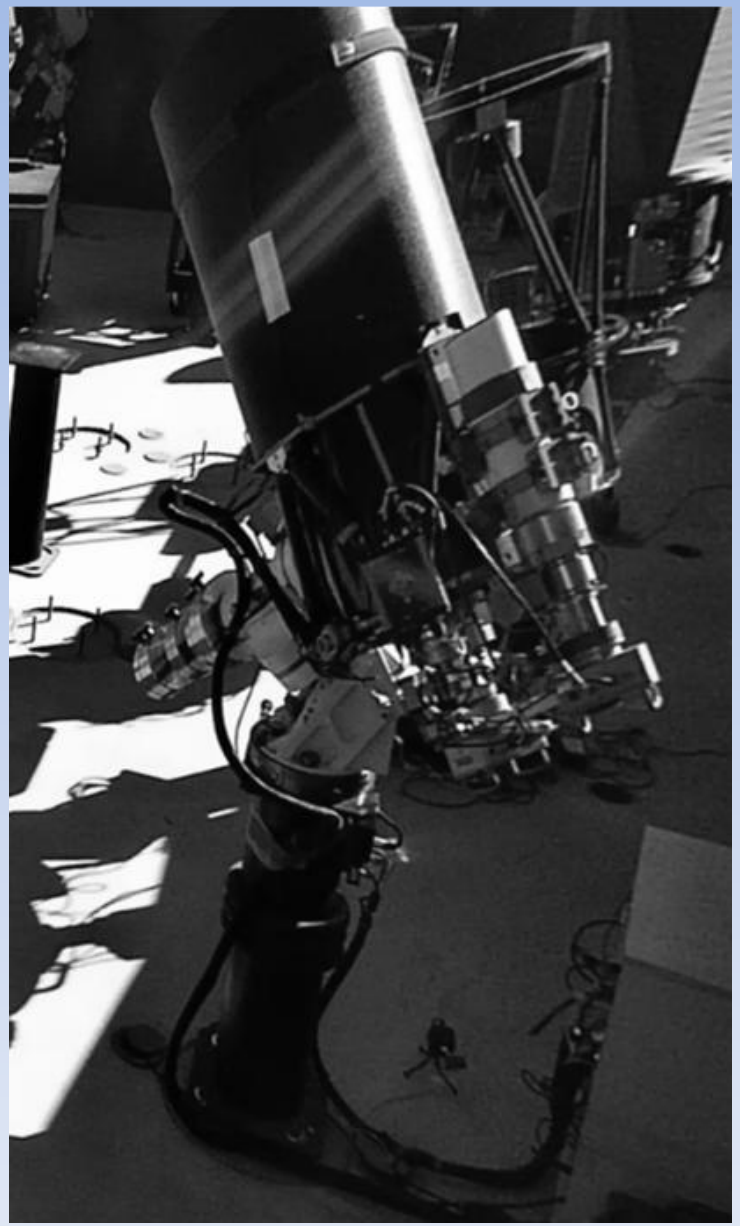
- March 2019
- 18 piers with 12 scopes at present

Inside Alpha

Inside Beta

DSW Beta Build Timelapse

My Scope at Deep Sky West



- AP-1200 GTO mount CP4 w Radio Shack 10A, 12v Power Supply
- Pegasus Ultimate USB/Power Hub with 10A, 13.8v Astron Power Supply derated to 12.8v
- Inclinometer, 2 dew heaters, hard light/dew shroud

<u>Scope 1:</u>

- TPO RC 12”
- Moonlite Focuser w Robofocus controller
- SBIG STF-8300m, filter wheel and OAG
- Ultrastar guide camera

<u>Scope 2:</u>

- WO 81 3 element Gran Turismo APO
- Moonlite Focuser w Ultimate Pegasus Focuser
- SBIG ST-8300c with OAG
- SBIG STi guide camera

- Computer: Shuttle PC (Intel i3, 256GB SSD)
  - Software
    - Windows 10
    - APCC Pro with meridian/horizon limits
    - MaximDL, FocusMax V4, CCDCommander
    - Prism for Scope 2

Pre-Install/Trip Summary

- Designed a hard light/dew shroud and attachment hardware for RC and got Astro Zap to make hard shroud
- Added inclinometer to rear bulkhead, and Dew heater for refractor
- Cables were labeled on both ends and wrapped with a weaved sleeve
- Build electronics cabinet and installed/tested all equipment
    - Included UPS
    - Separate power supply for mount per AP recommendations
    - Power switch: data loggers web power switch pro
- Using Team Viewer and Google Remote Desktop for remote access
- Using Google Drive to download image files
- Created Cable Connection diagram to leave with scope in water tight case

Pre-Install/Trip Summary (continued)

- For Transportation
  - Wrapped cabinet in cellophane with all cables for transportation
  - All telescope equipment wrapped in bubble wrap
  - Used moving blanket with several layers of bubble wrap as cushion for telescope in original shipping box
  - Everything fit in minivan, including my wheelchair, luggage for myself and helper

Install Summary

- Left home March 3, 2019
  - Stayed over night in Flagstaff
  - Stopped at meteor crater
- Arrived Santa Fe late afternoon of March, 4, 2019

- Arrived Deep Sky West Beta building on March 5, 2019 at 8:40am (less than hour drive out of Santa Fe)
  - Pier was mounted
  - Attempted to put AP pier adapter on pier and didn't fit. After initial panic that I had forgotten something, realized the pier was only 8" in diameter.
  - Luckily a scope was being moved out in other building, so could use that 10" pier. But had to wait for other scope to be un-mounted and pier brought over.
    - While waiting looked at assigned location (NE corner) versus scope in opposite corner and determined that my 2 scopes would be very close to East wall.
      - Talked to DSW co-owner and he forgot that I had two scopes.
      - So moved over to next pier to the West.

Install Summary (continued)

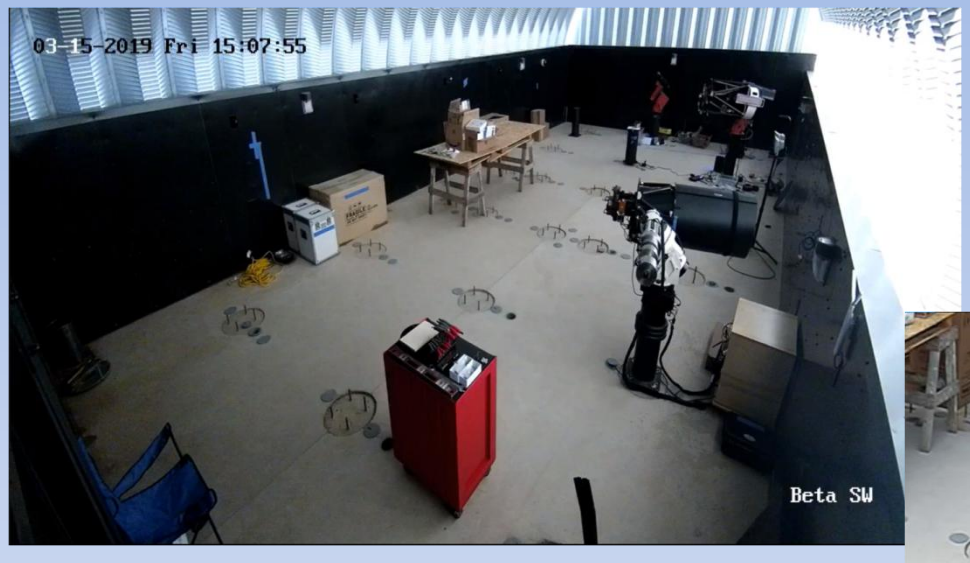
- Pier from other building was brought over but Pier would not fit bolt pattern in floor. Turns out contractor had not used a template to put bolts in concrete. So every pier had inconsistent bolt dimensions
  - Pier person was not available until late in day. DSW personal tried using hand grinder to open up holes. After an hour or more of grinding decided that wasn't going to work. So took pier to other locations to see which was closest to fitting. Found one that was close on south west side. About that time the Pier person arrived to do finally corrections and install.
  - It was late in day and with sunset approaching left to go back to hotel.
    - Didn't want to drive home from location in the dark for the first time (12-13 miles on a narrow dirt road, with half of it winding)
- Next morning, March 6
  - Installed scope and got running using site network, course PA using laser
    - Building was not oriented to true North, nor even magnetic North.
    - Supposedly the installed scope in far corner was polar aligned, so transferred its alignment to my scope. Turned out it wasn't polar aligned.

Install Summary (continued)

- March 7 & 8
  - Taped LED's, Cable management checks, set new location in sw.
  - Set park position and aligned camera's
  - Completed flats for WO81 using temporary easel
  - Labeled storage boxes
  - Course PA completed as roof was manually opened for me.
- Left for home March 9 from Santa Fe at 600 PST and drove straight through arriving at 1900

  - Could communicate with telescope from home on March 10, 2019
  - Roof became auto operational on March 18, 2019
  - Finalized PA with help from DSW IT person
  - Started Darks & flats, but noticed that camera would not hold temperature
  - Camera shipped from DSW to me on 4-1-2019
    SBIG fixed camera (bad fan motor) and shipped to me 4-12
  - Camera shipped to DSW 4-15-2019
  - Camera re-installed 4-20
  - Beta closed for roof repair; April 28 to May 12
  - Light panel permanently installed May 25 using articulating wall TV mount

DSW Beta Pictures shortly after leaving



Beta Orientation Video

https://www.youtube.com/watch?v=8GURj7inAR4&feature=youtu.be

Scope Horizon Limits

Scope can see

- About 20 deg elevation to the South
- About 5 deg elevation to the North
- East Elevation is greater than to the West (probably over 30 deg elevation)

Comparison of Clear Night Percentage vs location

Observatory Name, location	Clear Nights (min/ave/max %)
OCA Anza, CA	54-65-88
Sierra Remote Observatories, CA	47-64-89
Dark Skies Portal, NM	28-64-80
New Mexico Skies, NM	40-65-77
Deep Sky West, NM	42-60-73
San Pedro Valley Observatory, Az	33-67-84
Sky Pi, NM	34-61-74
Mt. Lemon, AZ	30-63-82
Kit Peak, AZ	33-67-84
Mt. Hopkins, AZ	29-65-84
Mt. Palomar, CA	48-65-87
VLA, NM	28-62-74

Data from www.cleardarksky.com

Deep Sky West, NM				
	Month Time Period Clear Nights [1]			Predicted Days Clear
Month (2018)	1 to 15	16 to End	Ave	
January	69.0%	65.0%	67.0%	20.8
February	63.0%	65.0%	64.0%	17.9
March	62.0%	67.0%	64.5%	20.0
April	62.0%	68.0%	65.0%	19.5
May	61.0%	63.0%	62.0%	19.2
June	59.0%	58.0%	58.5%	17.6
July	43.0%	43.0%	43.0%	13.3
August	42.0%	44.0%	43.0%	13.3
September	43.0%	62.0%	52.5%	15.8
October	67.0%	71.0%	69.0%	21.4
November	73.0%	69.0%	71.0%	21.3
December	64.0%	59.0%	61.5%	19.1
		Total		219.1
		Average	60.1%	18.3

[1] Prediction Source: www.cleardarksky.com

Deep Sky West Remote Observatory

Clear Sky Chart

History 2005-11-05 to 2017-12-20.

		Occurrence of each Forecast	Data Points
Cloud Cover	Day	4 3 1 3 3 2 4 4 5% 7% 60%	48753
	Night	3 3 1 3 3 2 3 4 5% 7% 61%	48273
Cloud Cover	Day	3 3 1 3 3 2 4 4 5% 7% 59%	48751
	Night	3 3 1 3 3 2 3 4 5% 7% 60%	48273
Transparency	Day	22% 4 9% 21% 26% 15%	48444
	Night	21% 4 10% 21% 26% 14%	48084
Seeing	Day	7% 10% 27% 31% 19% 4	5846
	Night	4 9% 30% 35% 18% 2	16113

Percentage Cloud Cover SW (2006-)

Color Meanings:

Overcast | 90% covered | 80% covered | 70% covered | 60% covered | 50% covered | 40% covered | 30% covered | 20% covered | 10% covered | Clear

Transparency (when cloud cover <= 30%)

Color Meanings:

Too cloudy to forecast | Poor | Below Average | Average | Above average | Transparent

Seeing (when cloud cover <= 80%)

Color Meanings:

Too cloudy to forecast | Bad 1/5 | Poor 2/5 | Average 3/5 | Good 4/5 | Excellent 5/5

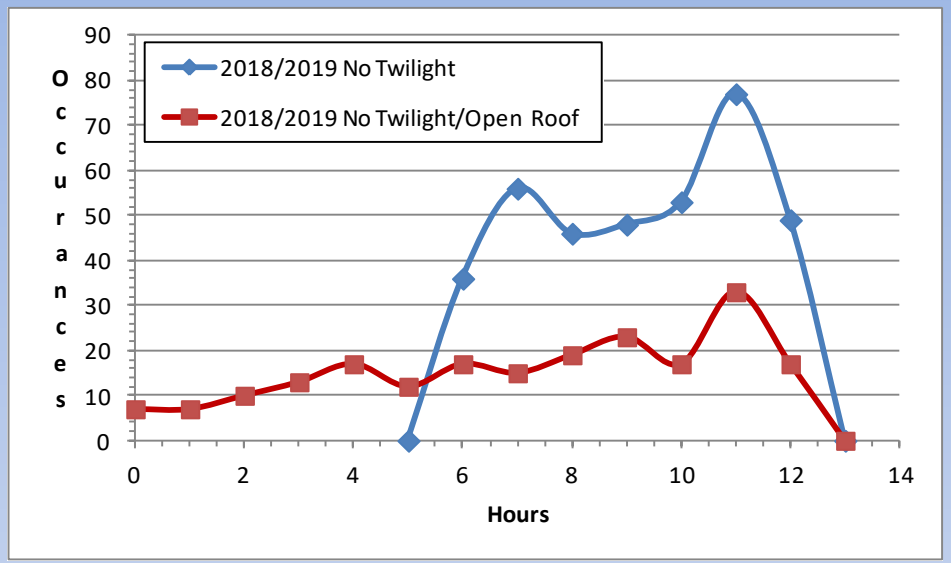
2018/2019 Deep Sky West Roof Openings and Seeing Statistics

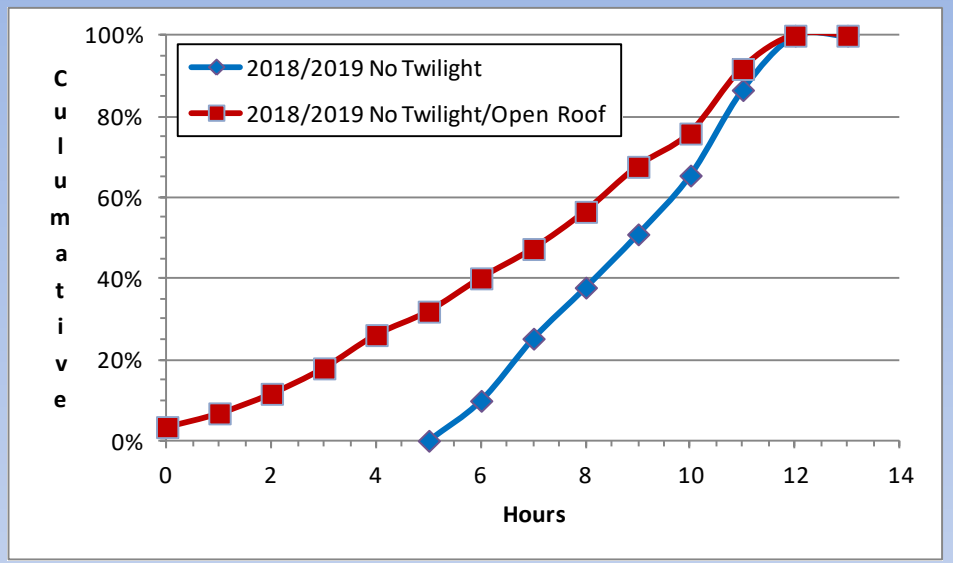
Month (2018/19)	No Twilight delta (hr)	Roof/No Twilight delta (hr)	Roof Open No Twilight (%)	Twilight No Moon delta (hr)	Roof/Twilight No Moon delta (hr)	Roof Open Twilight/No Moon (%)	Days Open (days)	Predicted Days Open (days)	Seeing (arc-sec)		
									Average	Standard Deviation	99% [1] Standard Error
Jan '19	339.4	166.2	49.0%	187.6	87.1	46.4%	20	20.8	2.58	0.68	0.52
Feb '19	286.1	148.9	52.0%	149.4	93.6	62.6%	22	17.9	1.78	0.39	0.59
Mar '19	283.8	101.9	35.9%	159.7	41.8	26.2%	18	20.0	1.90	0.39	0.37
Apr '19	235.7	108.1	45.9%	127.2	53.7	42.2%	18	19.5	1.89	0.32	0.23
May '19	203.9	31.7	15.6%	103.7	10.8	10.5%	7	19.2	2.02	0.25	0.19
Jun '19	175.9	80.8	45.9%	85.7	28.7	33.5%	18	17.6	2.08	0.34	0.30
Jul '18	193.9	33.2	17.1%	88.1	10.2	11.5%	7	13.3			
Aug '18	230.8	72.3	31.3%	104.3	31.3	30.0%	15	13.3			
Sep '18	262.6	168.5	64.2%	123.2	79.7	64.7%	22	15.8	2.15	0.39	0.30
Oct '18	307.2	118.6	38.6%	149.6	42.9	28.7%	15	21.4	1.75	0.28	0.24
Nov '18	323.4	210.0	64.9%	164.8	102.2	62.0%	25	21.2	2.06	0.47	0.27
Dec '18	346.5	158.8	45.8%	176.3	85.9	48.7%	19	19.1	1.99	0.53	0.39
Total	3189.1	1398.9	--------	1619.5	667.8	--------	206	219.1	--------	--------	--------
Average			43.9%			41.2%			2.04	0.48	--------

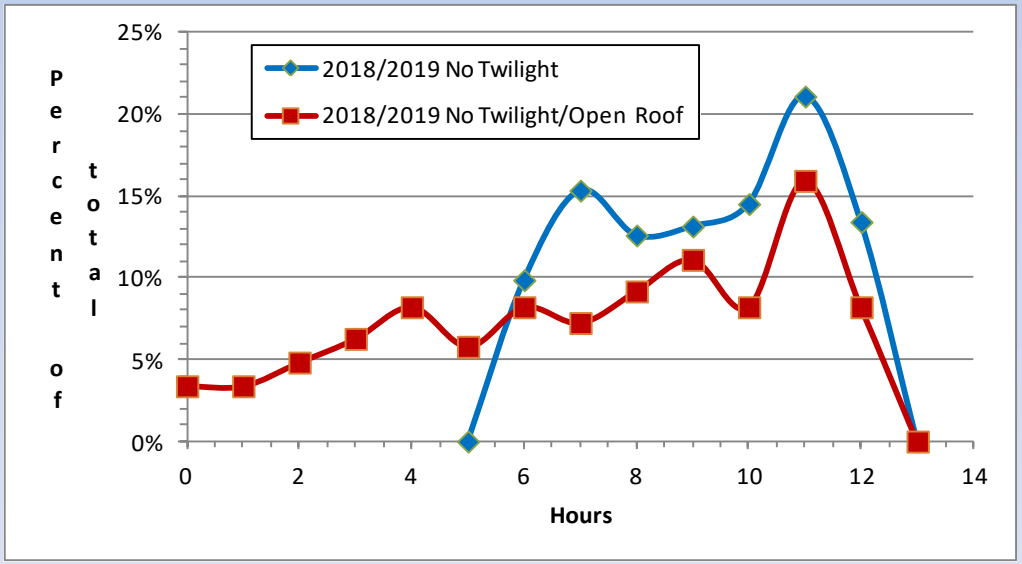
Note: Seeing data for July and August was not available

- Roof was opened 207 days from July 1, 2018 to June 30, 2019 between twilight hours and 206 days with No Moon
  - 15 days in April/May Roof was open, but didn't get roof closures times and don't know if roof was open between twilight times, so will assume it was, therefore……
    - Total days roof open = 222/221
  - Clear Sky Chart Math Model Prediction was 219 days

No Twilight with Open Roof Histograms







Days (hours) roof open between twilight hours

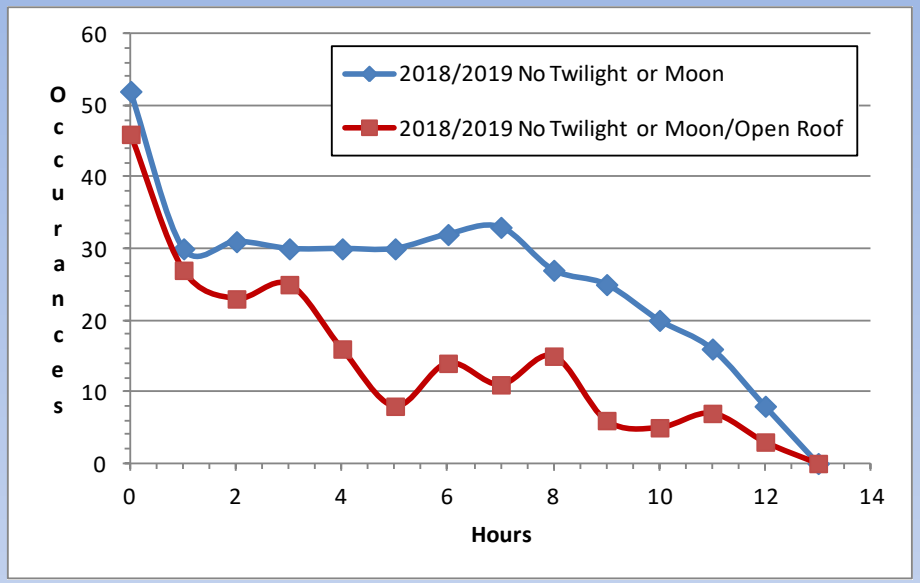
- 156 days (1131.1 hrs – 35.5%) roof opened/closed Once
- 34 days (178.2 hrs – 5.6%) Roof opened/closed Twice
- 12 days (66.8 hrs – 2.1%) Roof Opened/closed Three times
- 5 days (22.8 hrs – 0.7%) Roof Opened/closed Four times

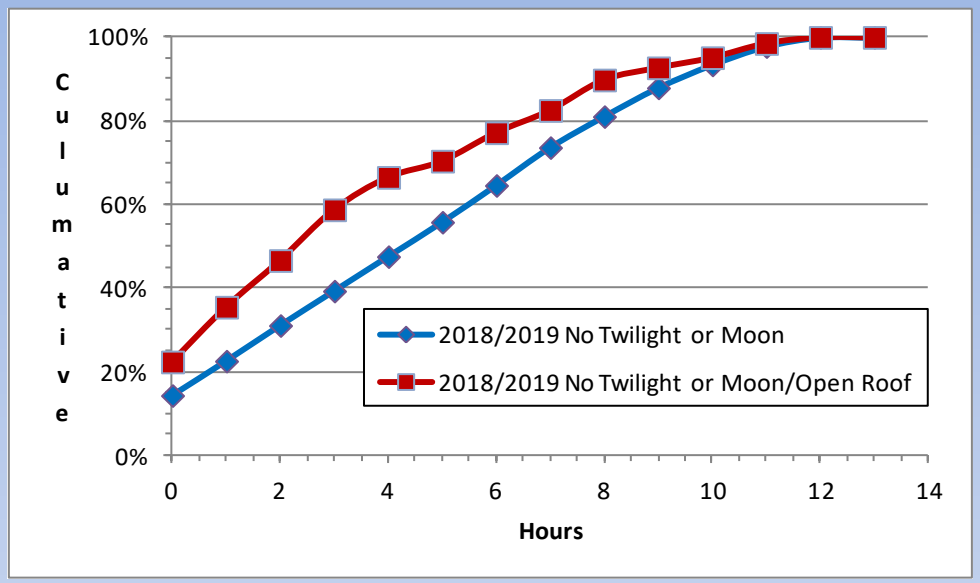
- Roof was open 1398.94 hours of possible 3189.08 hours or open 43.9% of the time between twilight hours

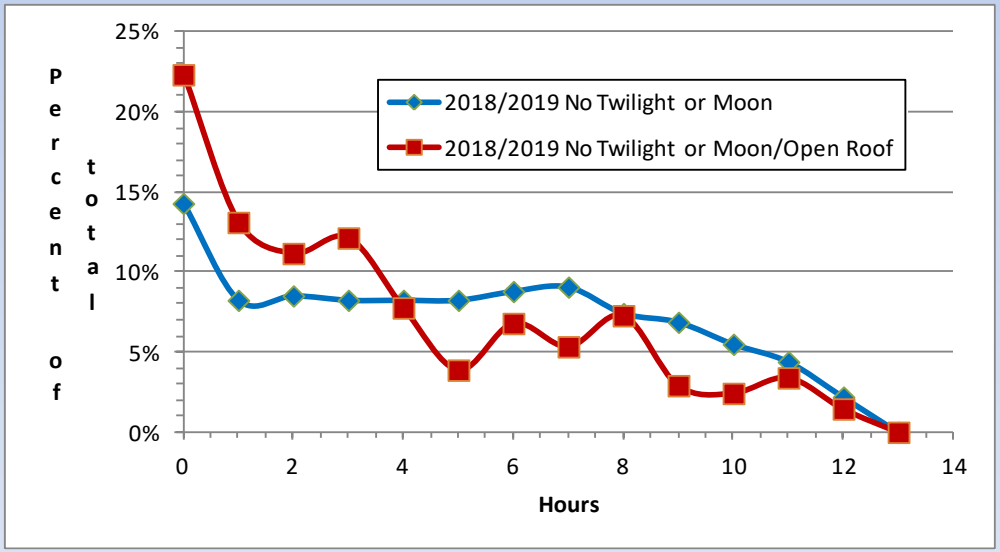
- Note: roof opening more than once, indicates variable conditions and possibility poorer conditions for imaging

Data: July 2018 to June 2019

No Twilight or Moon with Open Roof Histograms







Days (hours) roof open between twilight hours with No Moon

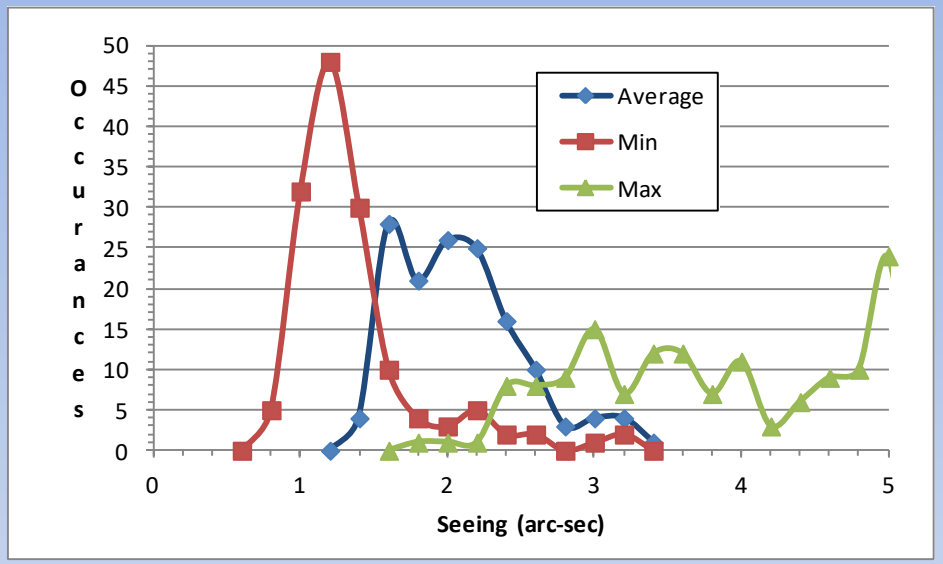
- 153 days (543.6 hrs – 33.6%) roof open for No Twilight or Moon
- 36 days (71.3 hrs – 4.4%) Roof opened/closed Twice
- 12 days (42.3 hrs – 2.6%) Roof Opened/closed Three times
- 5 days (10.5 hrs – 0.6%) Roof Opened/closed Four times

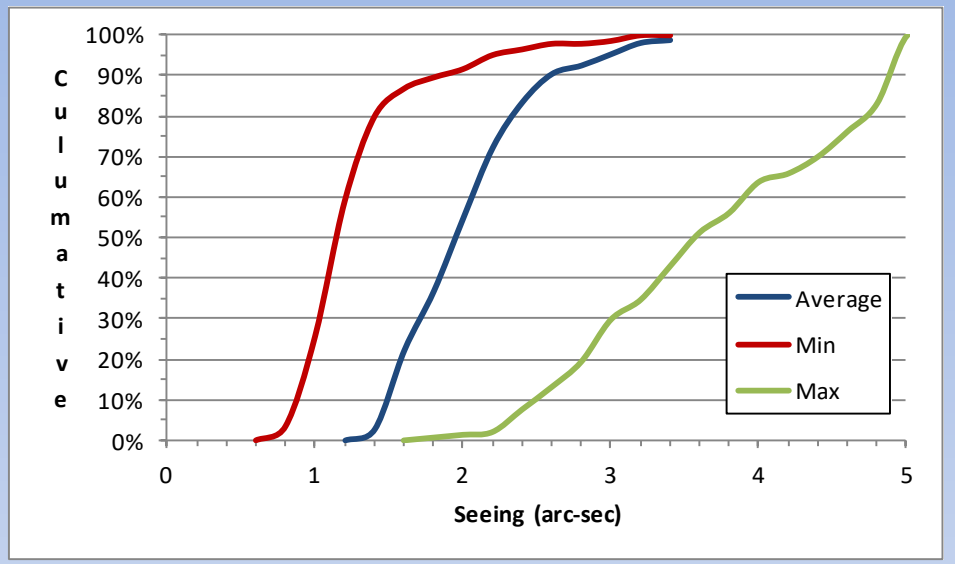
- Roof was open 667.79 hours of possible 1619.49 hours or open 41.2% of the time

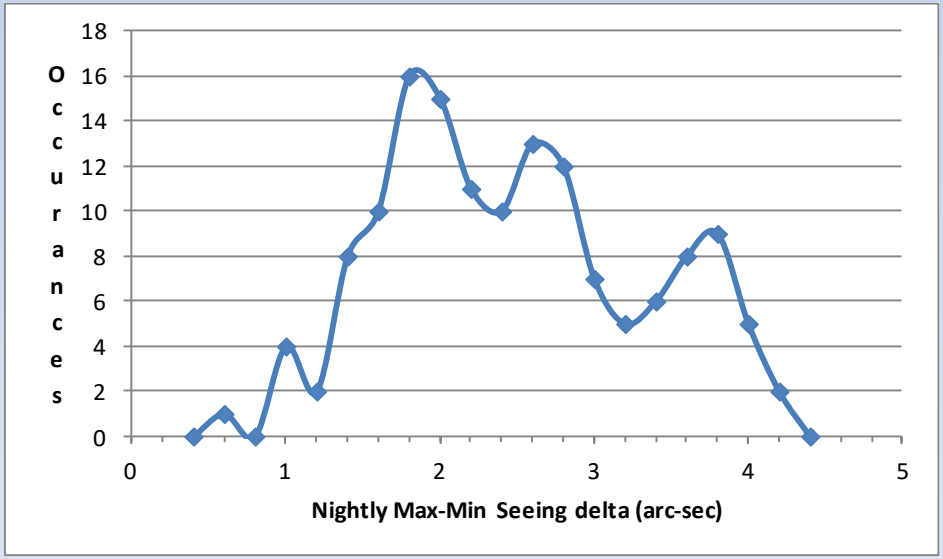
- Note: roof opening more than once, indicates variable conditions and possibility poorer conditions for imaging

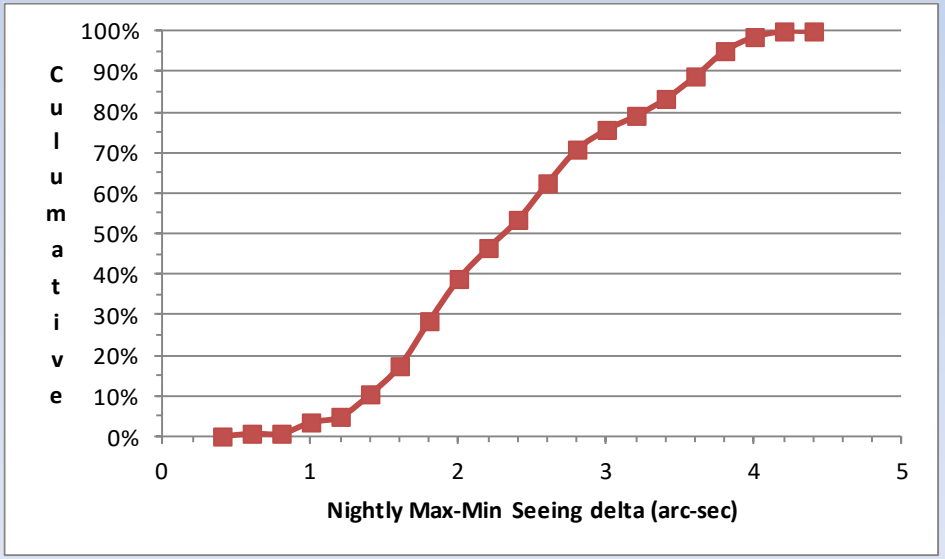
Data: July 2018 to June 2019

2018/2019 DSW Seeing Statistics









Data: September 2018 to June 2019

Night Viewing Opportunities and Imaging hours captured

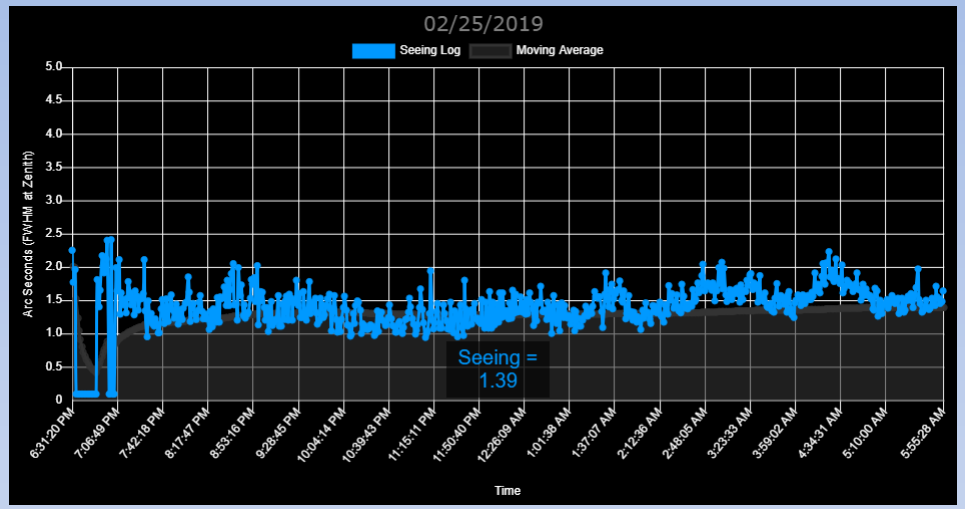
	All night viewing (nights)	Opportunities (nights)	(%)	Hours captured (hrs)	Seeing (arc-sec)
March	5	31	16.1	0.7	1.9
April	5	30	16.7	4.7	1.89
May	2	31	6.5	34.8	2.02
June	7	30	23.3	56.2	2.08
July	9	31	29.0	34.5	2.15
August	6	31	19.4	34.5	2.47
September	10	30	33.3	95.3	1.75
October	16	31	51.6	154.2	2.65
	Total	Total	Average	Total	Average
	60	245	24.5%	414.9	2.05

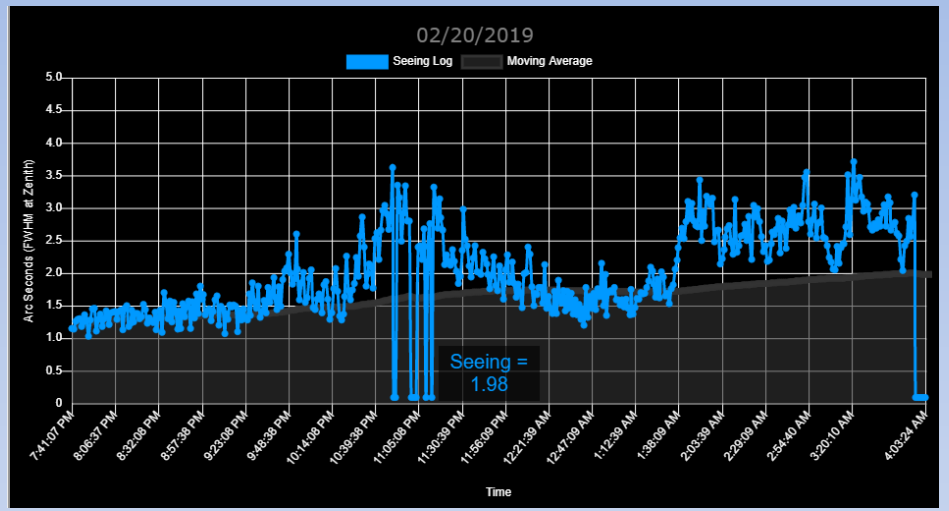
- 37.2% hours to date captured in October
- 60.1% hours to date captured in September/October

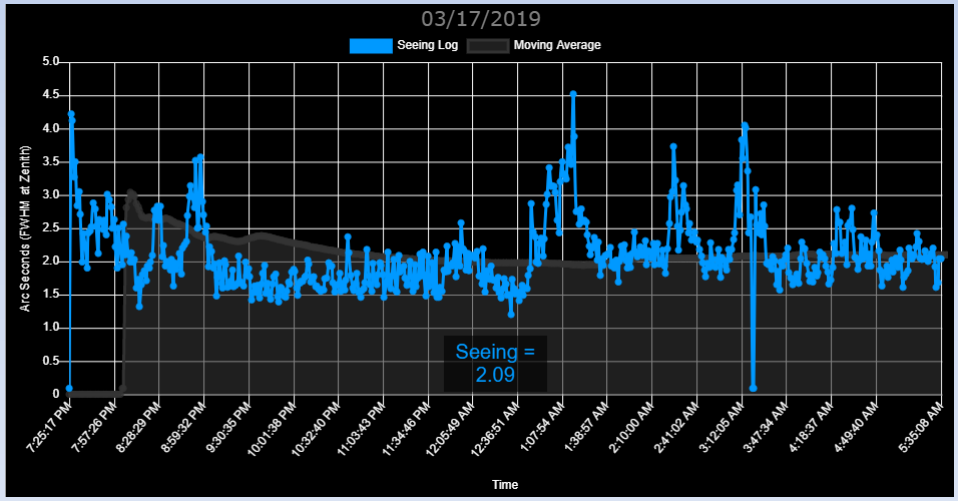
- Cost per image hour = $20.25

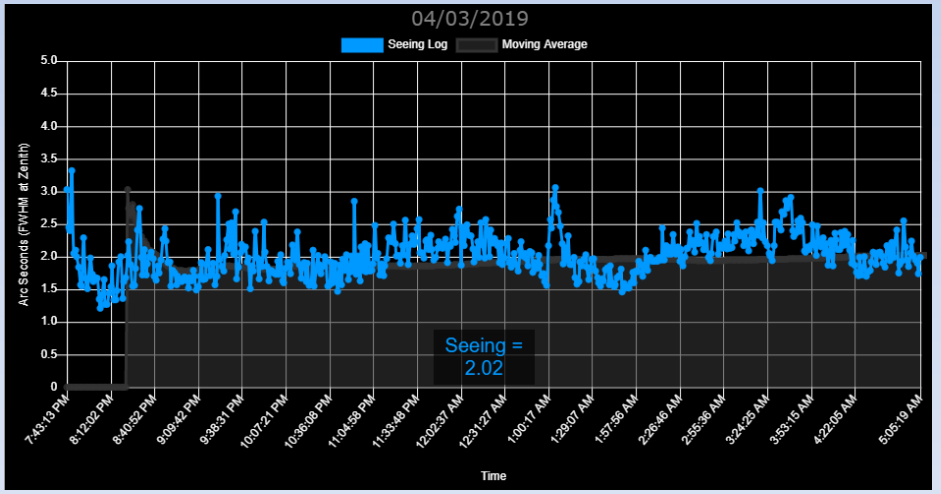
Data collected on 13 objects
- 8 data collection complete
- 2 data collections on-hold
- 3 data collections in progress

DSW Seeing graphs - Examples









Power Outages March 13, 2019 to June 30, 2019

5 power outages that appeared to depleted my UPS Battery [1]

- DSW Power Failure Wed, 13 Mar 2019 20:14:34 -0600 (MDT)
- Event Notification Time 2019-03-21 12:07:40 Utility power failure
- Event Notification Time 2019-03-24 14:45:09 Utility power failure
- Event Notification Time 2019-04-28 16:45:56 Utility power failure

- 1 power outage lasted 19 seconds
- 36 power outages lasting from 2 to 5 seconds (7 occurred after/before twilight)

[1] Received UPS email notification of loss of utility power and on battery, never received notification of power restored, so assume UPS power depleted and PC shut off. On one occasion did see UPS was not fully charged and in process of recharging after a loss of utility power

Issues/Problems Encountered

Problem 1:
Running imaging script, MaximDL stopped in middle of exposure. Script kept waiting for exposure to end, meanwhile mount kept tracking….scope hit APCC horizon limit and parked mount. **Unresolved but Mitigated**

Problem 2:
Running script, focus max stopped, scripted stopped/exited without running power down actions, mount stopped (unknown reason). Upon parking the next morning, mount did not go to park position. Off in elevation. Moved scope back to park 4 position using inclinometer. Re-initiated mount to park 4 . **Unresolved**

Problem 3:
User Error: tried to image object below APCC horizon limit. APCC parked upon exceeding

Problem 4:
Focus max selected star too dim, times out at 10 minutes, and retries, usually successful. Not sure what problem is? Wrong catalog star magnitude , plate solve error or initiation error. Usually occurs at first focus of night with narrowband. **Unresolved**

Issues/Problems Encountered

Problem 5:
Weather text file had daylight flag come on during night and then darkness a few minutes later. Had script set to park if daylight occurred. Decided didn't need so removed. **Unresolved but Mitigated**

Problem 6:
Do not have Roof status, just access to weather text data file. Script parks mount with a weather pause. When good weather again, script waits 45 minutes before resuming. Ensures roof is open before resuming. Had used 35 minutes and that wasn't enough. **Resolved and Mitigated**

Problem 7: Script only allows "begin to track" or "resumes last action" after weather pause ends. Because delay can be several hours, need plate solve as first action and another focus before resuming imaging. This can not be done, unless an ASCOM script can be written and added as an external script. Sometimes script does not continue after the end of a weather pause. To help mitigate, plate solve and focus is done every hour. **Somewhat Mitigated**

Problem 8: Windows 10 update requiring restart interrupted session causing all software programs to end….leaving mount tracking to continue….caught in time before pier crash. Need to ensure restart hours are outside observing time and window update is stopped during imaging. **Mitigated Maybe**

Issues/Problems Encountered

Problem 9:
Remote SW: primary -Team viewer, secondary -Google Remote Desktop

Team viewer shut me down, saying I was using SW for commercial use. Appealed, but they replied that free Team viewer was for “family and friends” only. I pointed out that their website said the definition of commercial use included use outside just family and friends usage. No response.

Google changed the remote desktop SW to a web based system. Depending upon bandwidth, speed could be slow.

Primary is now remote PC, with Google remote desktop as secondary

My Lessons Learned

1) Make sure site has everything ready and you have plenty of time allowed (took me 4 nights, they said they were ready, but they weren't so lost a day)

2) Have backup plan in case skies are not clear to do polar align while there

3) Make sure cable bundles are tight and will be clear in all scope positions

4) Need weather data file if don't have roof status. include additional time margin for roof to open after weather message says clear.

5) Make site IT person your buddy

6) Take tape to cover LED's....amazing how much light is given off without tape

7) Don't install around new moon as impacts others who maybe operating telescope starting at end of astronomical twilight. Amazing how many no moon nights are lost due to weather....No moon nights are premium
(Scope installed at far end of observatory during new moon. Head-lamps and computer screen on for several hours after astronomical twilight end. Imaging opposite direction with hard light shroud prevented losing an image)

My Lessons Learned (continued)

8) Another option for a course home position....using the light panel as a reference and rely on plate solve to improve

9) If installing during winter, bring hand/feet heater

Biggest Surprises

1) Can not find a weather prediction site that is accurate in predicting weather
2) Weather is very variable and is only good for two/three nights in a row. Seems like weather is better after midnight.
   - Only September was best for number of images captured with better than average seeing.
   - October was best for number of images, but with poorest seeing
3) Cloud sensors aren't very good at determining cloud cover
4) Session planning is more difficult if taking advantage of shooting images with moon up. Need narrow band objects. But to complete Narrow band objects need no moon image time. So narrow band objects compete with LRGB during no moon image time.
5) Been using APCC for AP mount control, but saw no need to using pointing model as using plate solve. After watching an Astroimaging channel presentation on APCC pointing model, implemented pointing model and my tracking improved. APCC has a tracking error correction algorithm based on a pointing model.

DSW Background vs Anza

Data Capture: SBIG STF-8300m, -10 deg C, 10m, Luminance

Anza Median 2159 ADU, Noise 62.84
DSW Median 1740 ADU, Noise 51.1
Bias 1040 ADU

DSW has a

- 37.4% Background reduction
- 18.7% Noise reduction

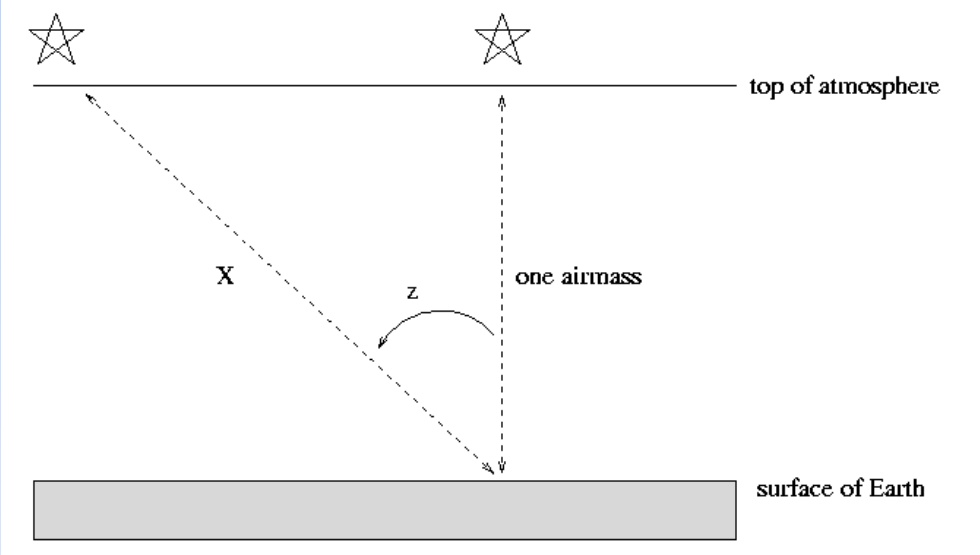
NGC 3718 LRGB(18,5,5,5hrs)

Atmospheric effects: extinction and seeing

As light passes through Earth's atmosphere, it suffers from two types of degradation:

1) extinction: stars become dimmer
2) seeing: stars become blurry

The amount of extinction depends on how much air light rays must traverse. Astronomers have devised the term **airmass** method to describe this quantity: one airmass is the amount of air directly above an observer. So, if you are looking at a star at the zenith, you are looking through one airmass.

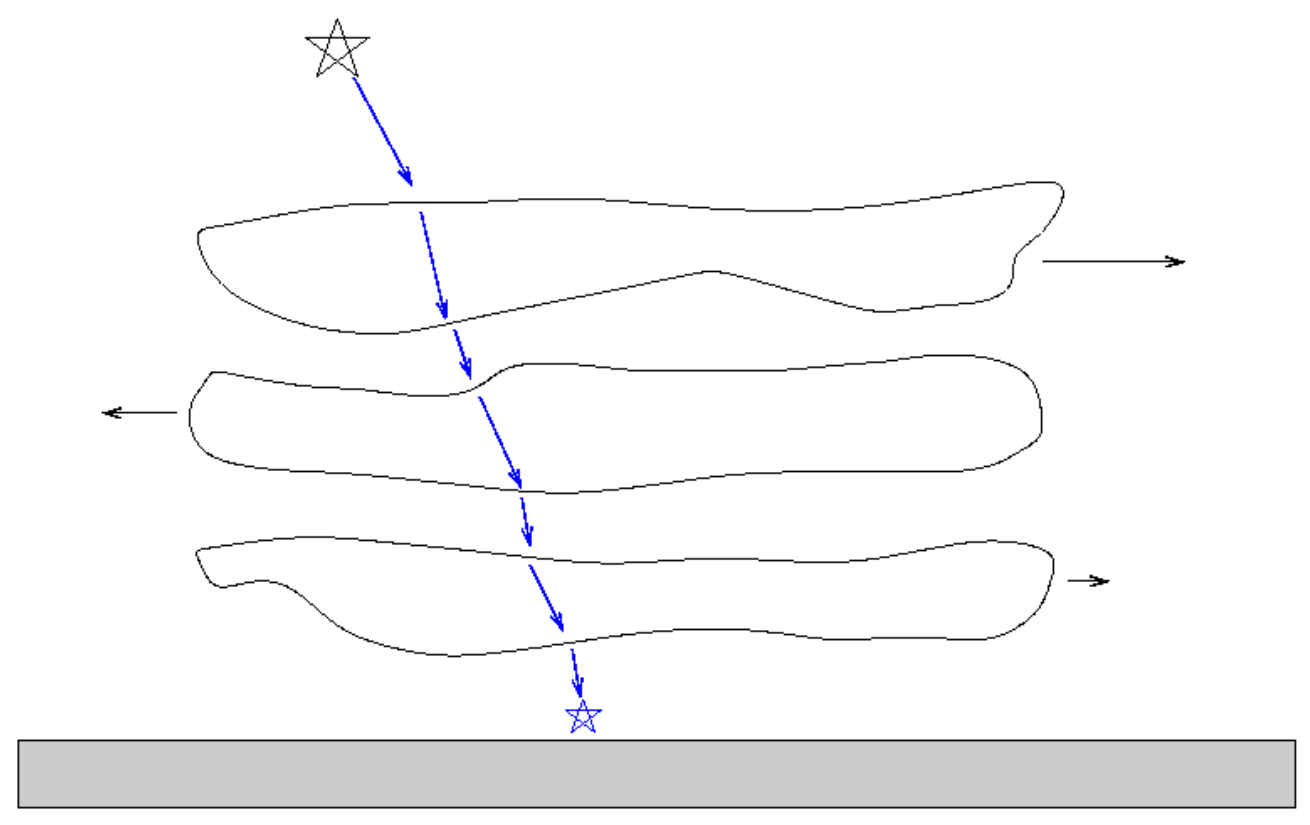


http://spiff.rit.edu/classes/phys445/lectures/atmos/atmos.html

Blurring by Earth's atmosphere

As light makes its way through the Earth's atmosphere, it passes through many different layers of air. Each layer has a slightly different temperature, pressure and density; there may also be slight differences in chemical composition, dust and water content. That means that the **index of refraction** of each layer is a little different.

Light rays passing through these layers are refracted by constantly changing amounts. On timescales of tens of milliseconds, the apparent position of a star will change by fractions of an arc-second:



Blurring by Earth's atmosphere (continued)

If your target is some angular distance away from the zenith (z), then its light travels a longer distance through the Earth's atmosphere before it can reach you. To a reasonable approximation, one can consider the Earth and its atmosphere to be flat, parallel slabs. In that case, the distance light travels is

Airmass = one airmass/ cos(z)

Zenith angle (z)	Airmass ratio
0	1.00
10	1.02
20	1.06
30	1.15
40	1.31
50	1.56
60	2.00
70	2.92
80	5.76
85	11.47

Data Collection Guidelines gather from web and experienced astro imagers

No Moon: L, R, G, B, O

- L, B, O: Alt $\geq$ 50°
- G: Alt $\geq$ 40°
- R: Alt $\geq$ 30°

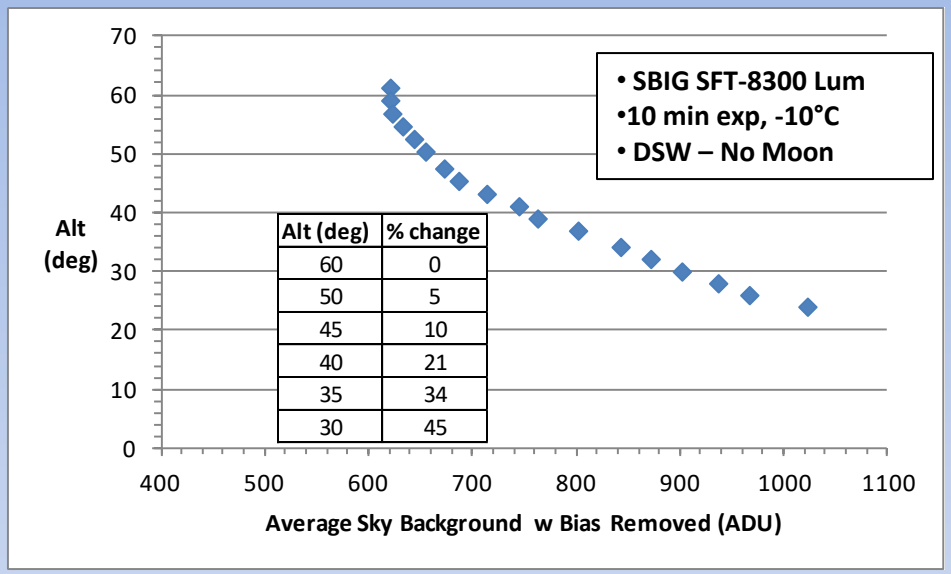
Moon: Ha, S: Alt $\geq$ 30°

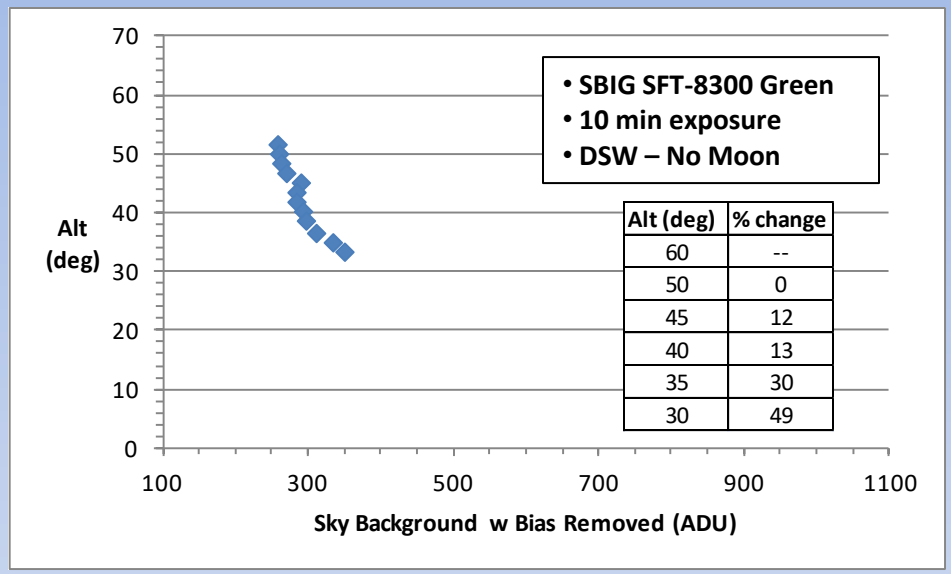
- Full Moon distance $\geq$ 60°
- 1/4 Moon distance $\geq$ 30°

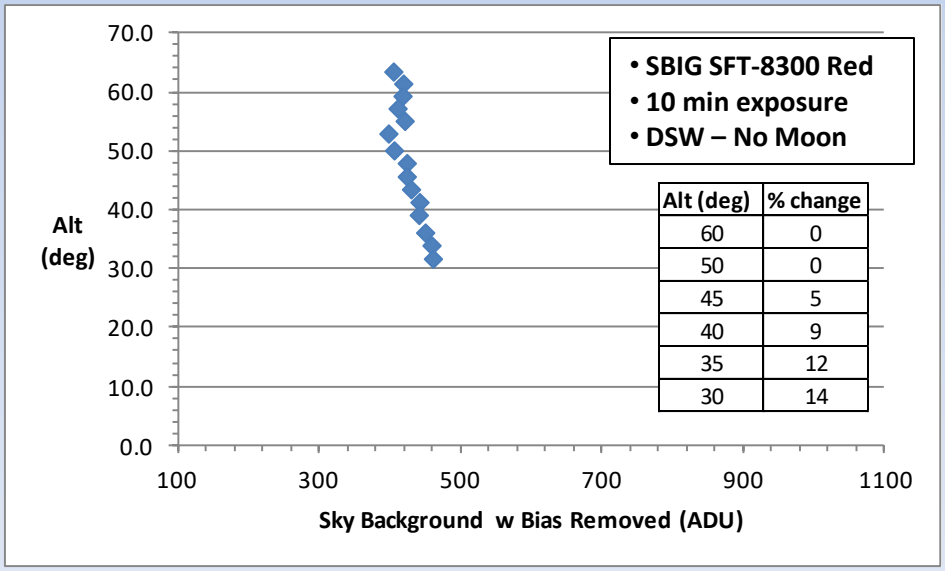
The next series of chart attempts to justify the above guidelines (Used over 400 hours of image capture data)

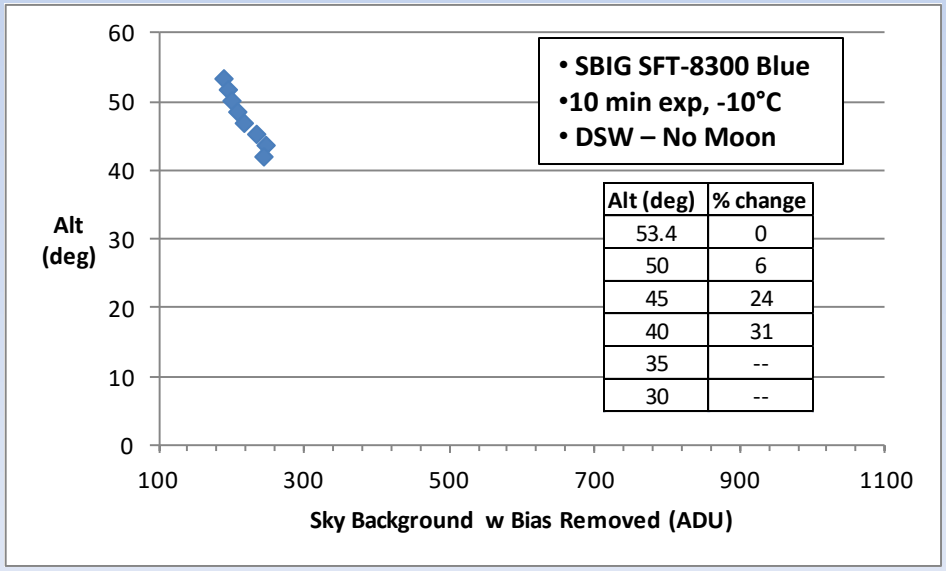
LRGB Background Sensitivities

•Selected data to emphasize sensitivity









LRGB Filter Altitude Limits based on Sky Background Median percentage increase

		Altitude (deg)				
		50°	**45°**	**40°**	**35°**	**30°**
Filter	**Lum**	5%	10%	21%	34%	45%
	Red	0%	5%	9%	12%	14%
	Green	0%	12%	13%	30%	49%
	Blue	6%	24%	31%	**No data**	**No data**

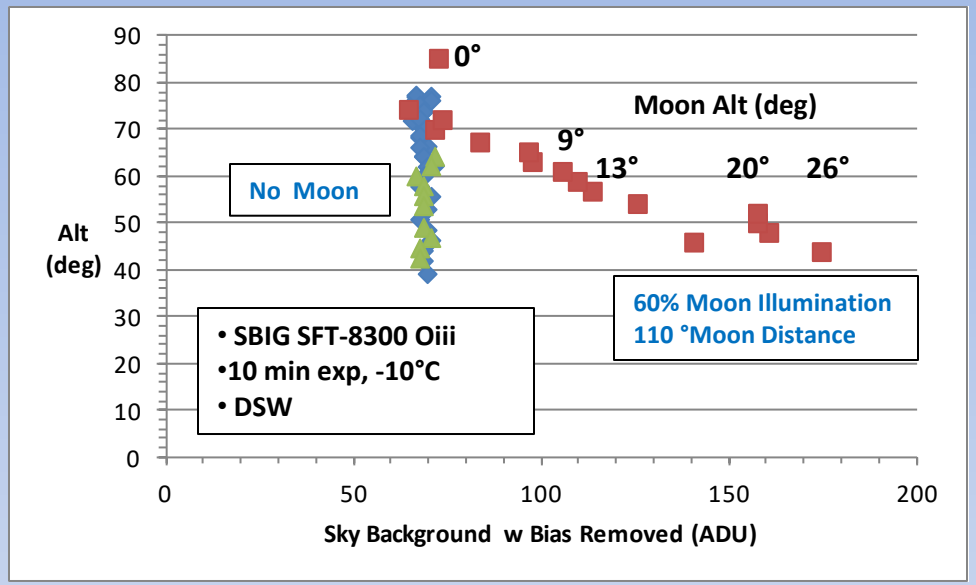
Sky Background Median increase Percentage	Filter				
		Lum	**Red**	**Green**	**Blue**
	5%	50°	45°	50°	50°
	10%	45°	40°	45°	50°
	15%	45°	30°	40°	50°
	20%	40°	30°	40°	45°

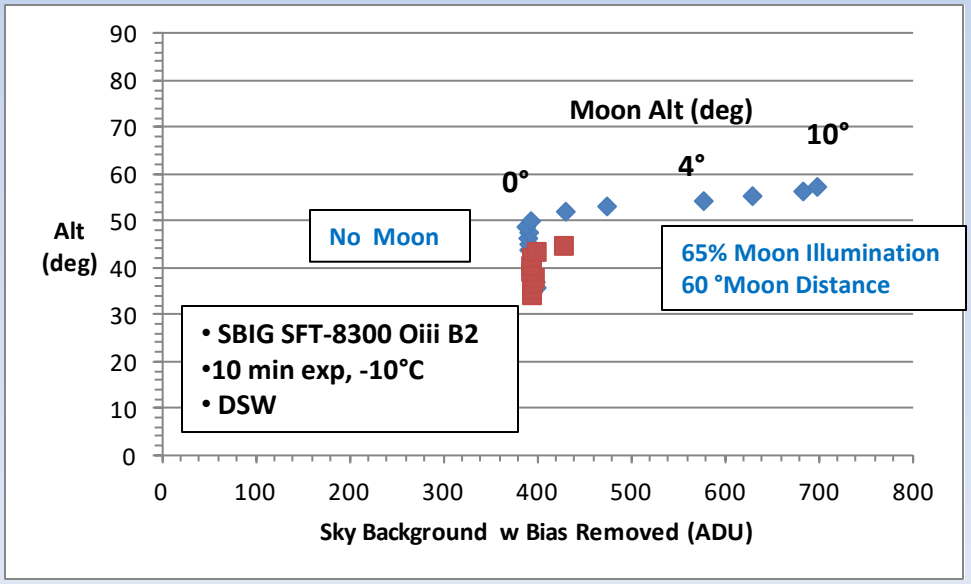
Alt limit based on % increase

Alt selected based on data rounded off to nearest 5%

Oiii Background Sensitivities

Baader Oiii– 8.5nm

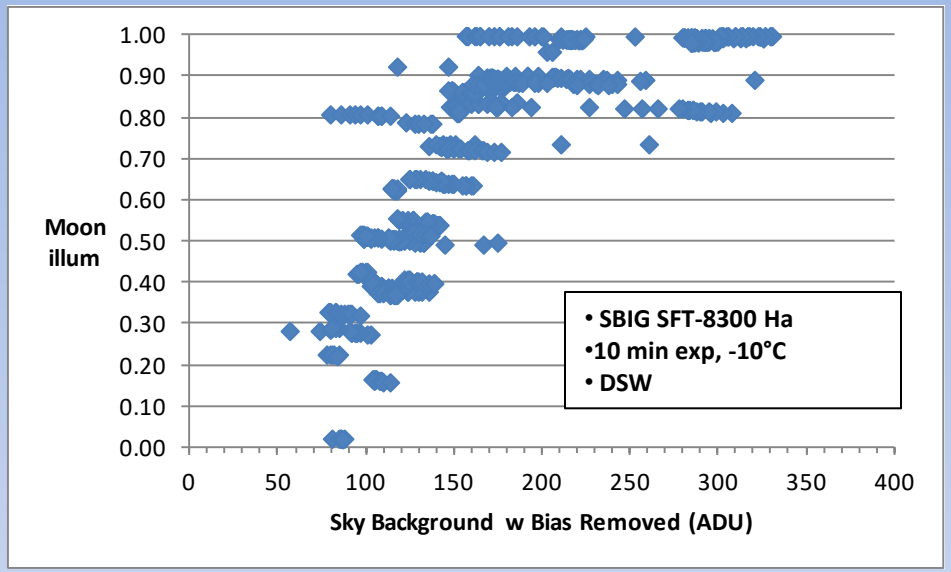




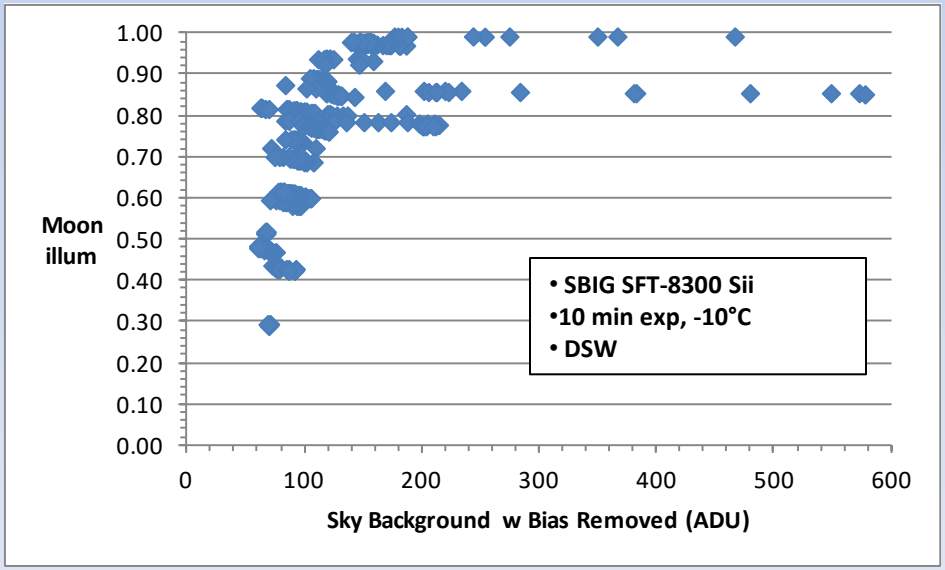
- Oiii images should be captured
  - During No Moon conditions
  - Alt > 30 deg

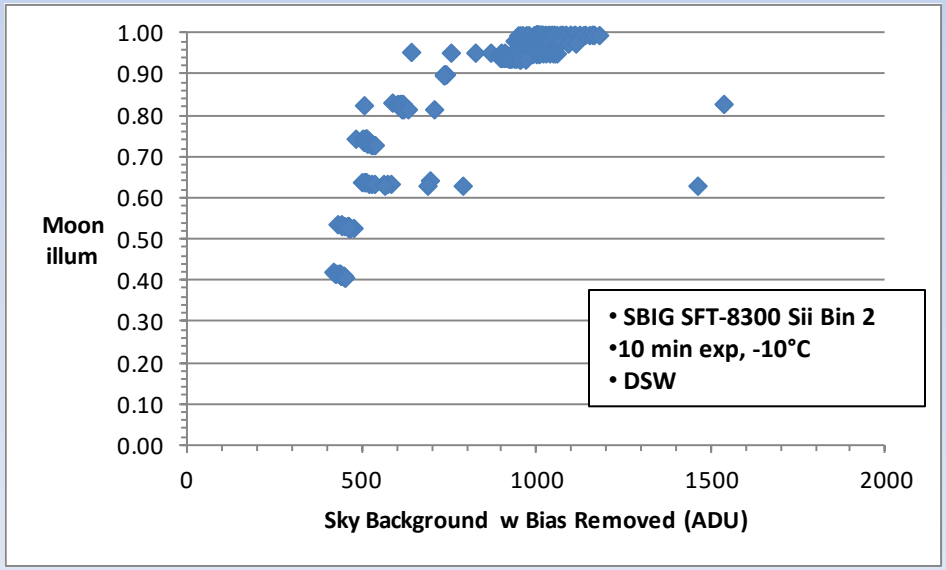
•Selected data to emphasize sensitivity

Ha & Sii Background Sensitivities

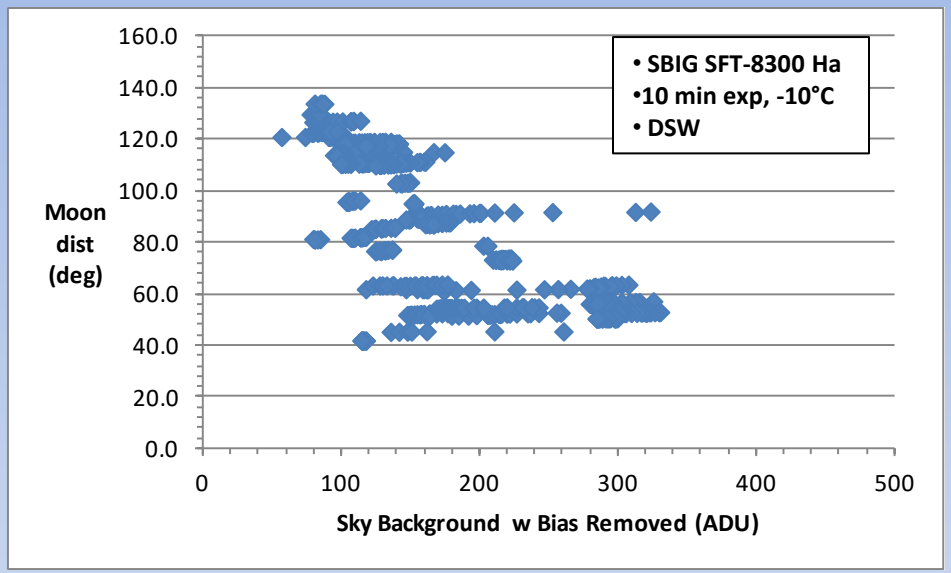


- All available data covering different objects, days, altitudes, moon distance and moon illumination

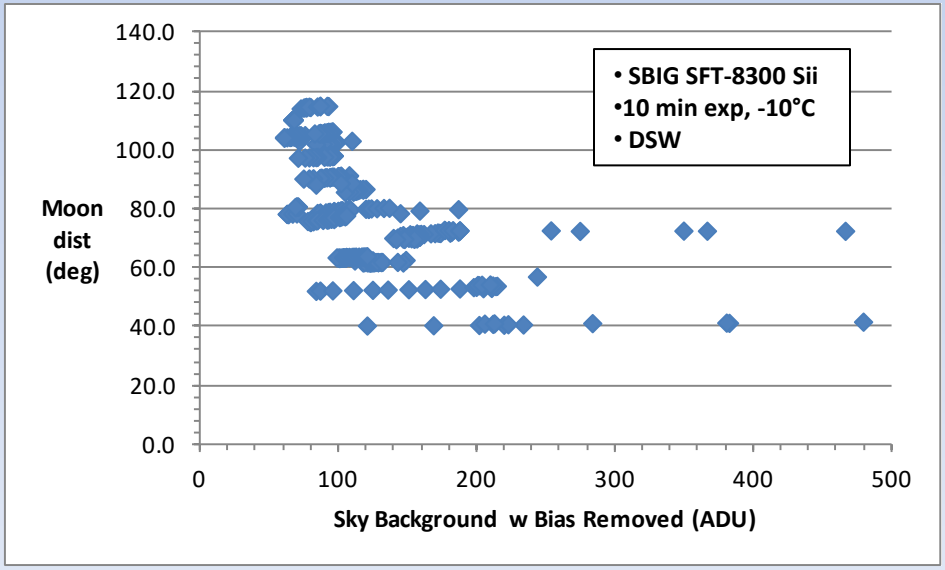


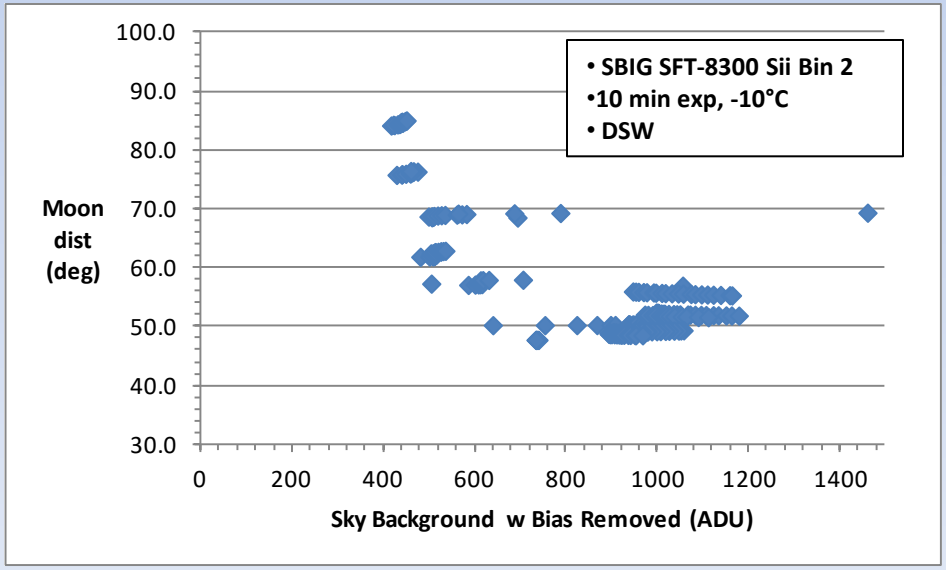


Ha & Sii Background Sensitivities



- All available data covering different objects, days, altitudes, moon distance and moon illumination



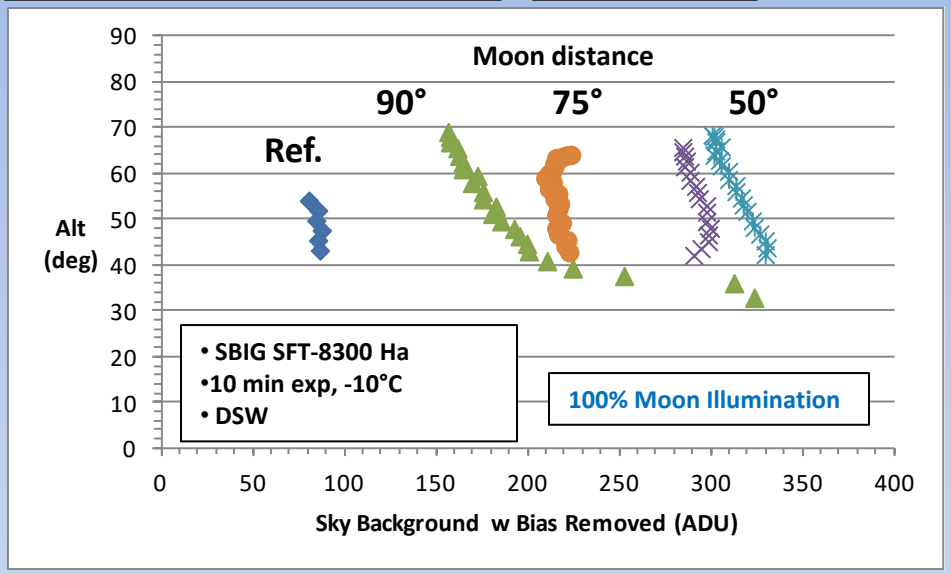


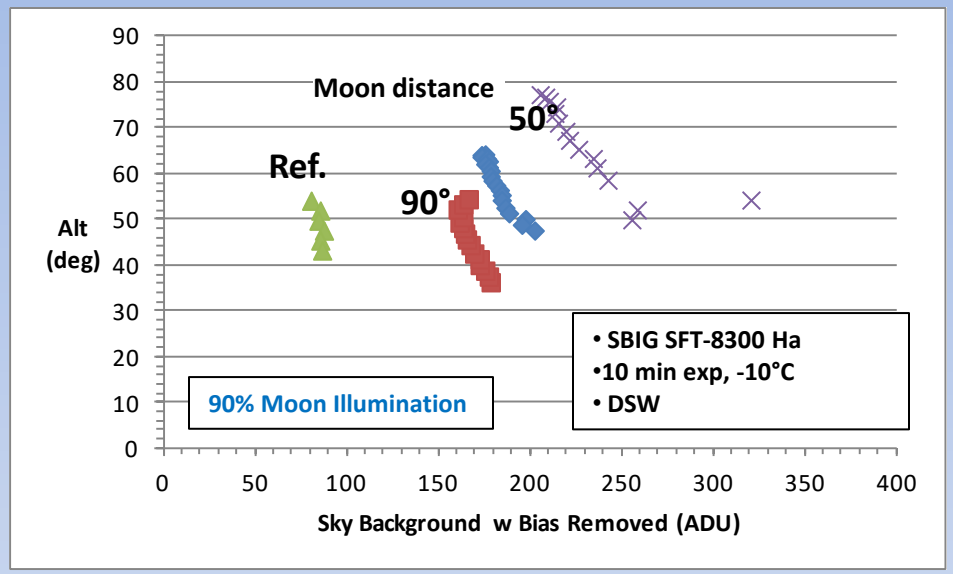
Ha Background Sensitivities

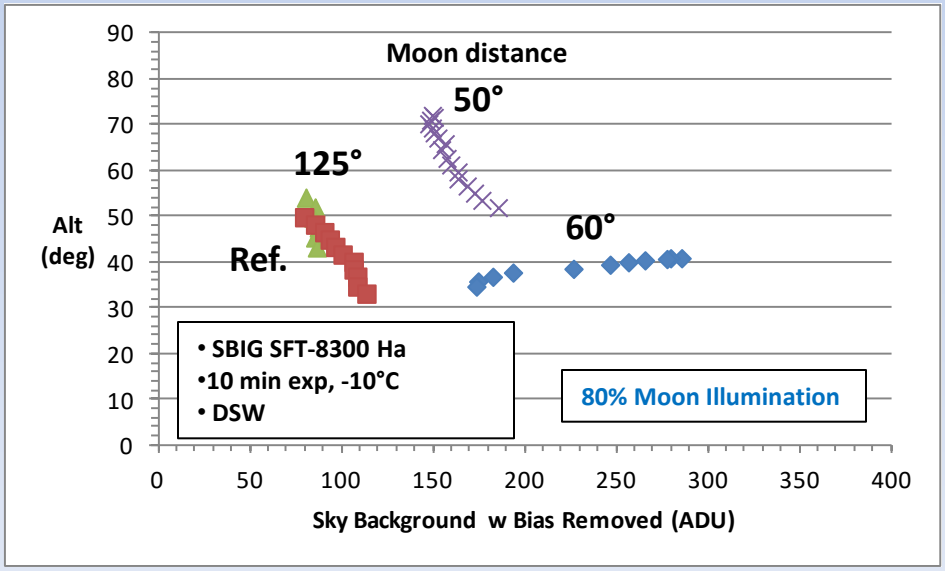
Ref: New Moon, 135 ° Moon Separation

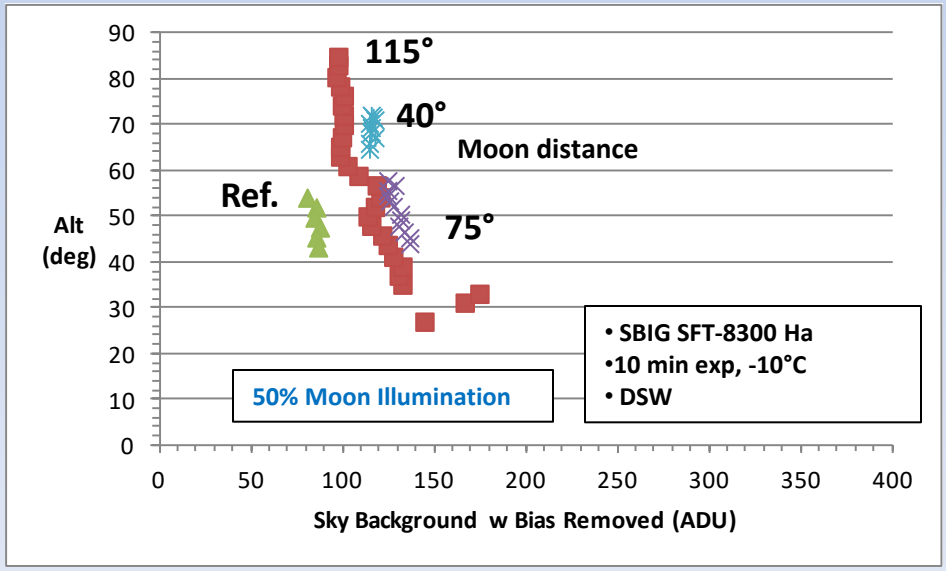
Baader Ha – 7nm

•Selected data to emphasize sensitivity



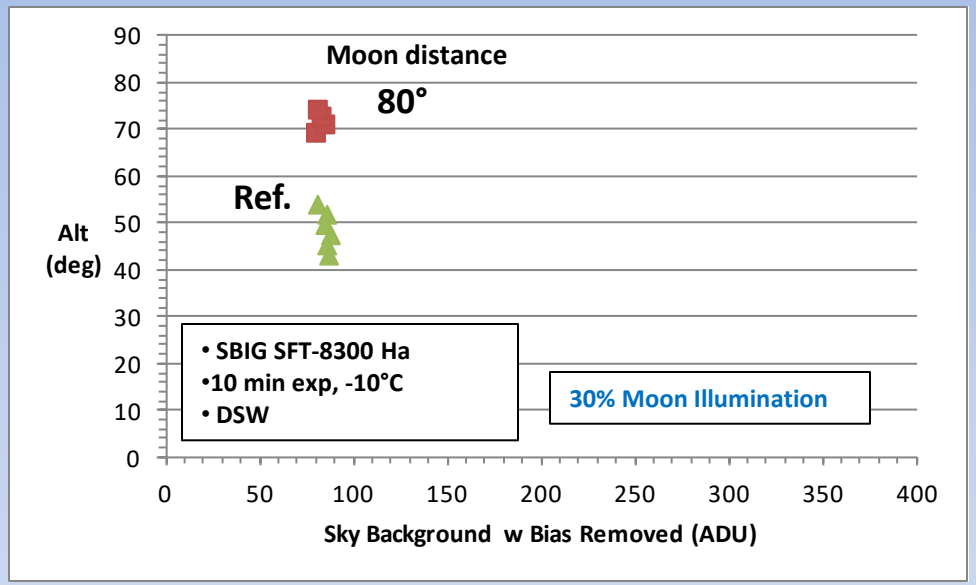






Ha Background Sensitivities

Ref: New Moon, 135 ° Moon Separation

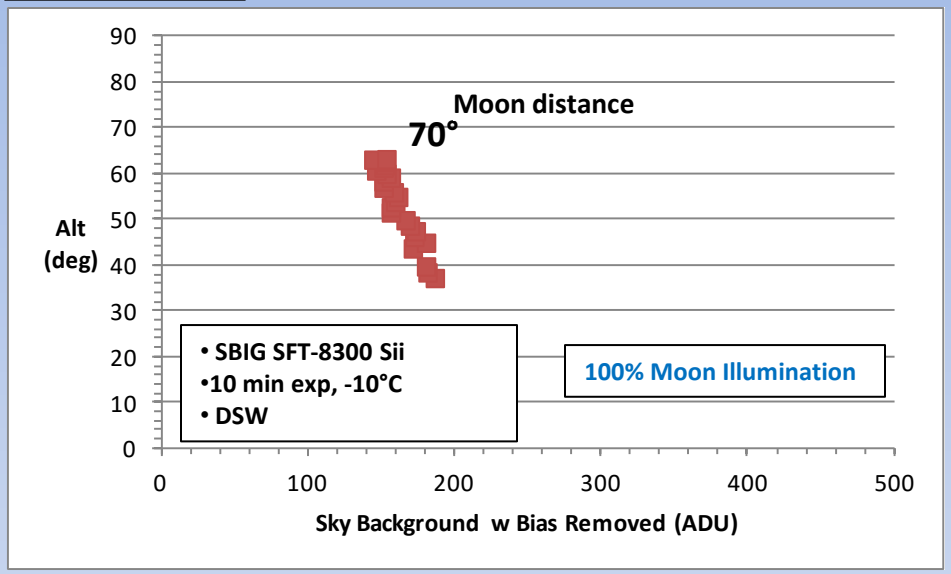


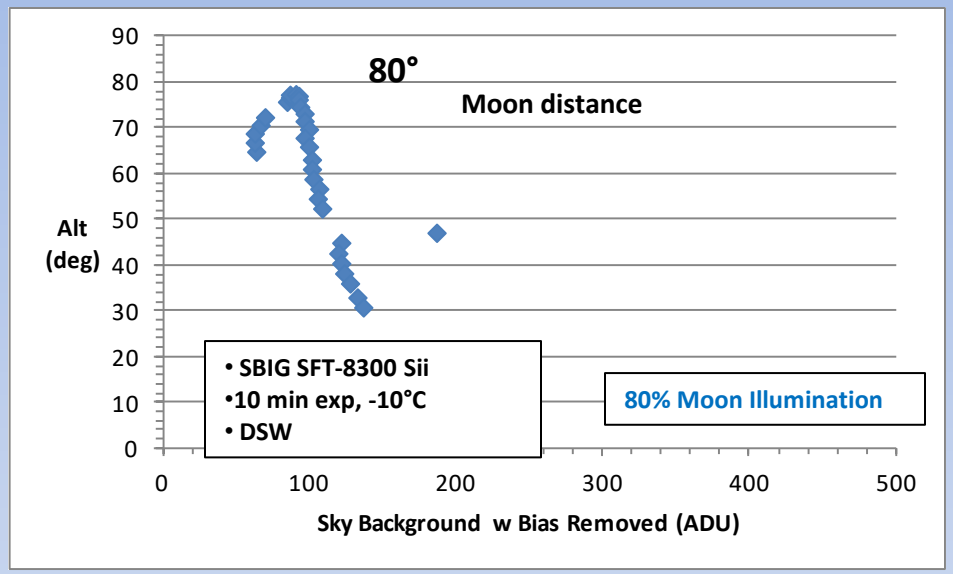
•Selected data to emphasize sensitivity

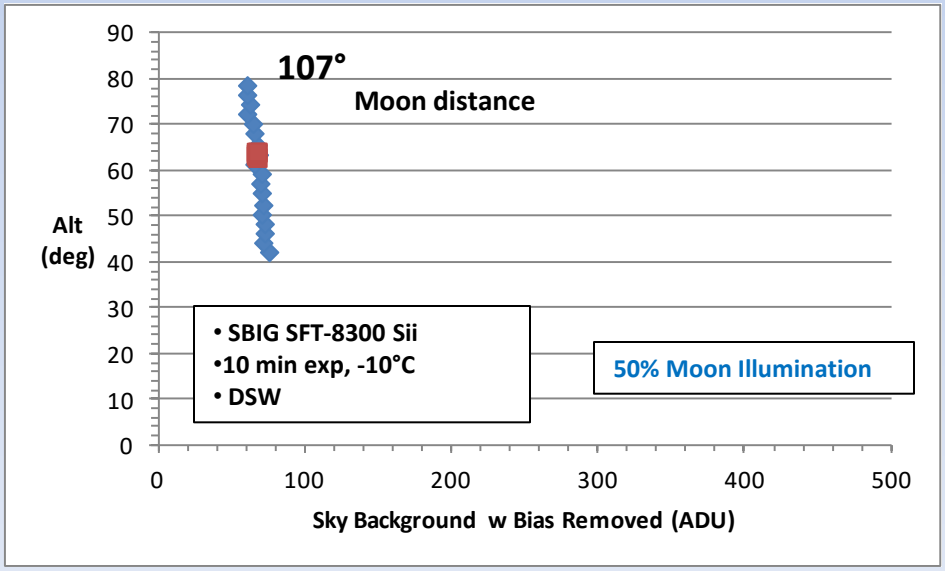
Sii Background Sensitivities

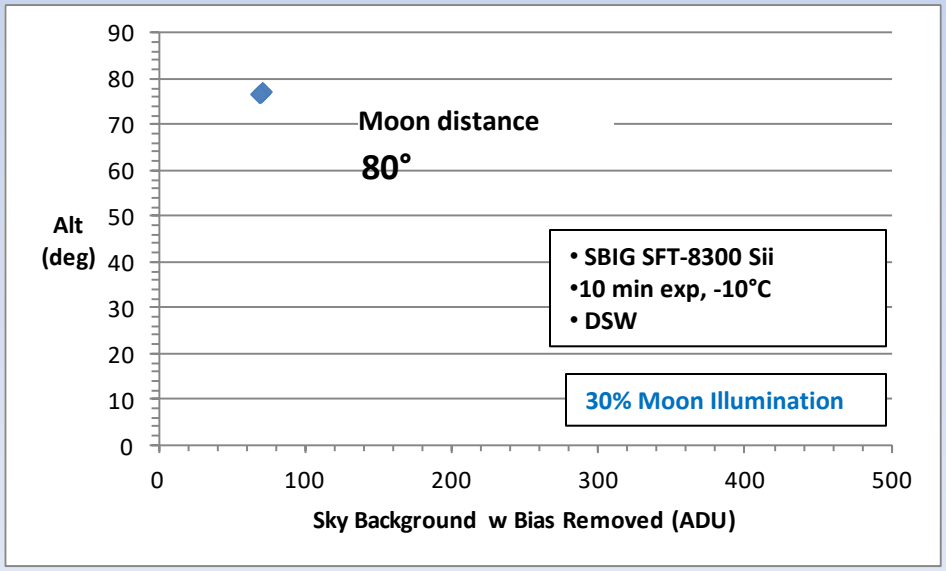
Baader Sii – 8nm

•Selected data to emphasize sensitivity



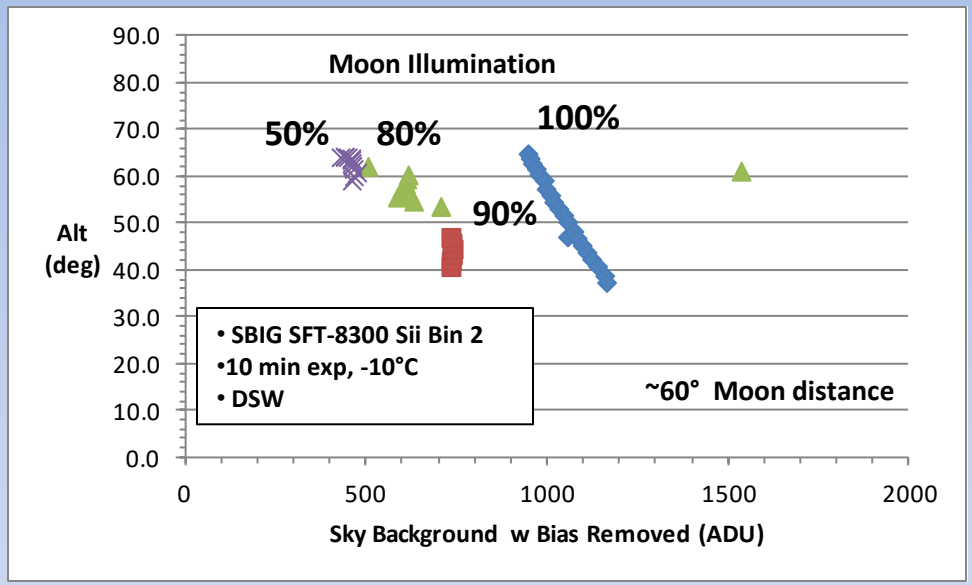






Sii Bin 2 Background Sensitivities

•Selected data to emphasize sensitivity



Narrow Band Filter Environment Limits

Web search
Shoot Ha and S narrow band during

- Full moon; Moon distance > 60 deg
- ¼ moon; Moon distance > 30 deg

- My data indicates
  - The moon distance needs to be increased by a factor of 2
  - Best to not shoot during full moon

- 95% to 95% Moon phase = ~5days
- 90% to 90% Moon phase = ~7 days
- 85% to 85% Moon phase = ~8 days
- 80% to 80% Moon Phase = ~9 days
- 50% to 50% Moon Phase = ~15 days

Number of Imaging Nights Loss in a Month vs Moon Illumination Window

Image Capture Guidelines Summary

Starting Assumption

No Moon: L, R, G, B, O

- L, B, O: Alt $\geq$ 50°
- G: Alt $\geq$ 40°
- R: Alt $\geq$ 30°

Moon: Ha, S: Alt $\geq$ 30°

- Full Moon distance $\geq$ 60°
- 1/4 Moon distance $\geq$ 30°

Analysis Conclusions from available data

- L guidelines seems to assume a background increase of 5%
  - (since L is so important may want to increase altitude constraint to 55 or 60°)
- R,G,B guidelines seems to assume a background increase of 15%
- Oiii guidelines seems to be overly constrained….analysis indicates altitude can be reduced to 30°
- Ha, Sii guidelines seems to be not constrained enough…..analysis indicates moon distance needs to be doubled. Not shooting during full moon reduces the moon distance constraints, especially if Binning (not enough data to quantify moon distance).

- Effects of shooting images while moon is up can be reduced by using narrower Ha/Sii bandwidths than author used in generation of data for analysis

- Note: data not available to determine R,G, B background effects if binning