My Adventures to Remote Observing

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OCA AstroImagers SIG

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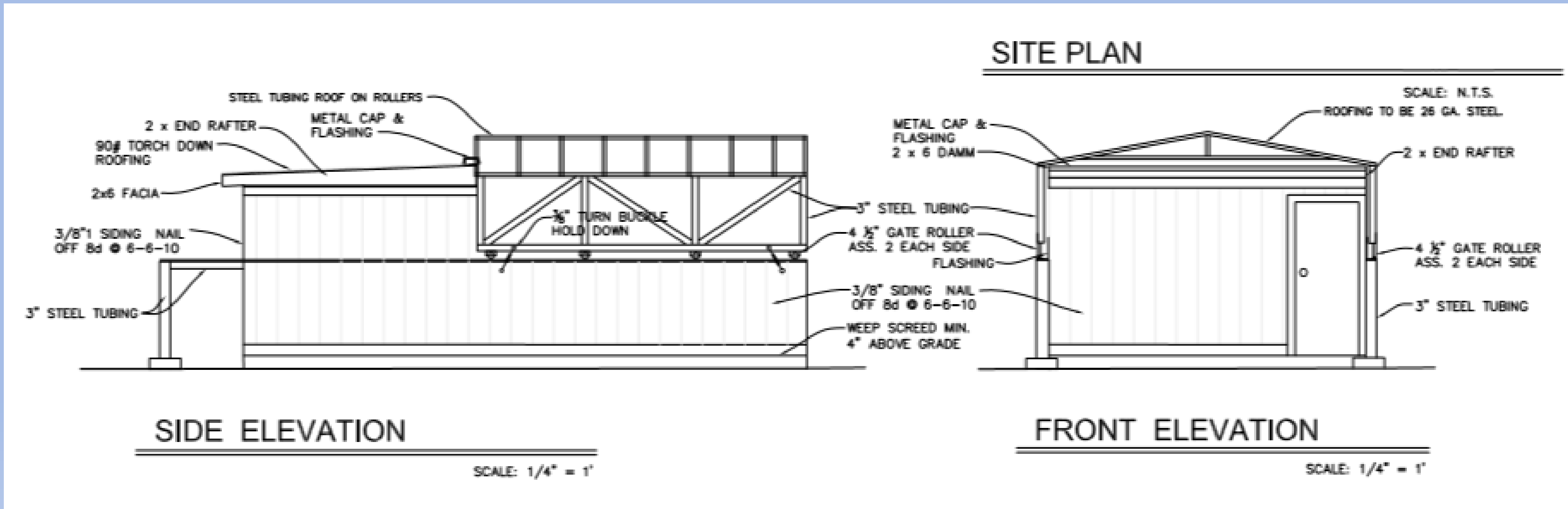
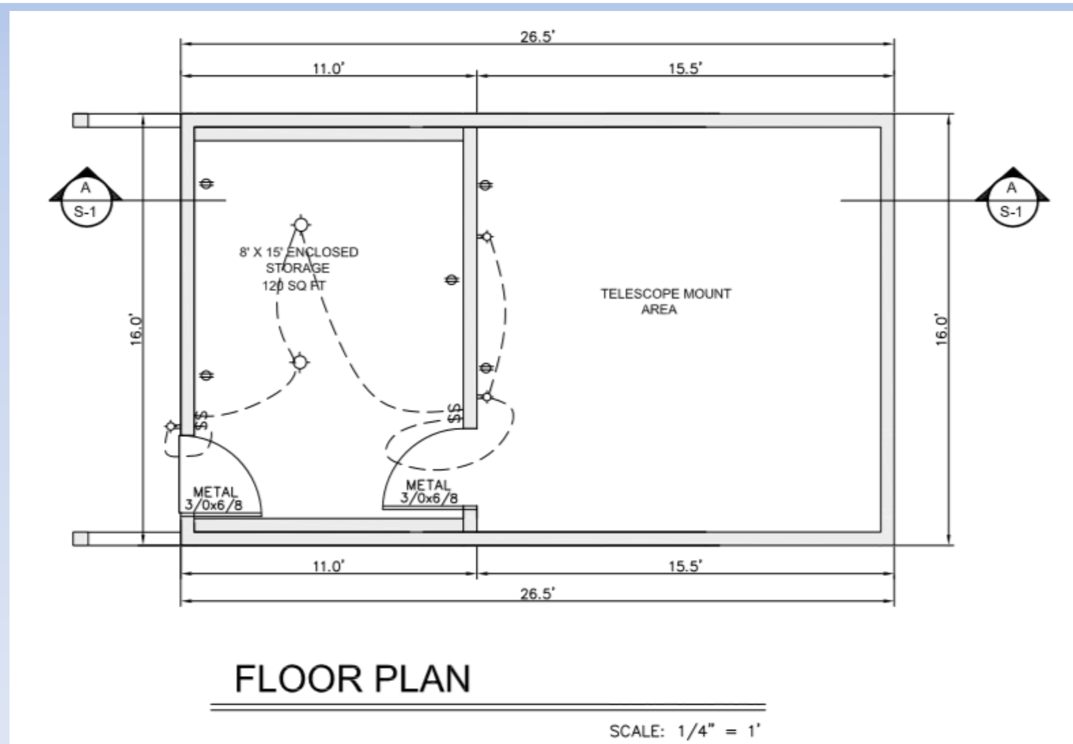
My Anza History

- In August 1990 purchased a pad at the OCA Anza site in 10 pad alley (west end, pad #1 or 2).
  - Mounted my 8” Dall-Kirkham
  - Only kept pad for a couple of years.

- Sometime around fall of 2004 started teaching the Beginner’s Class at the Orange Country Astronomers

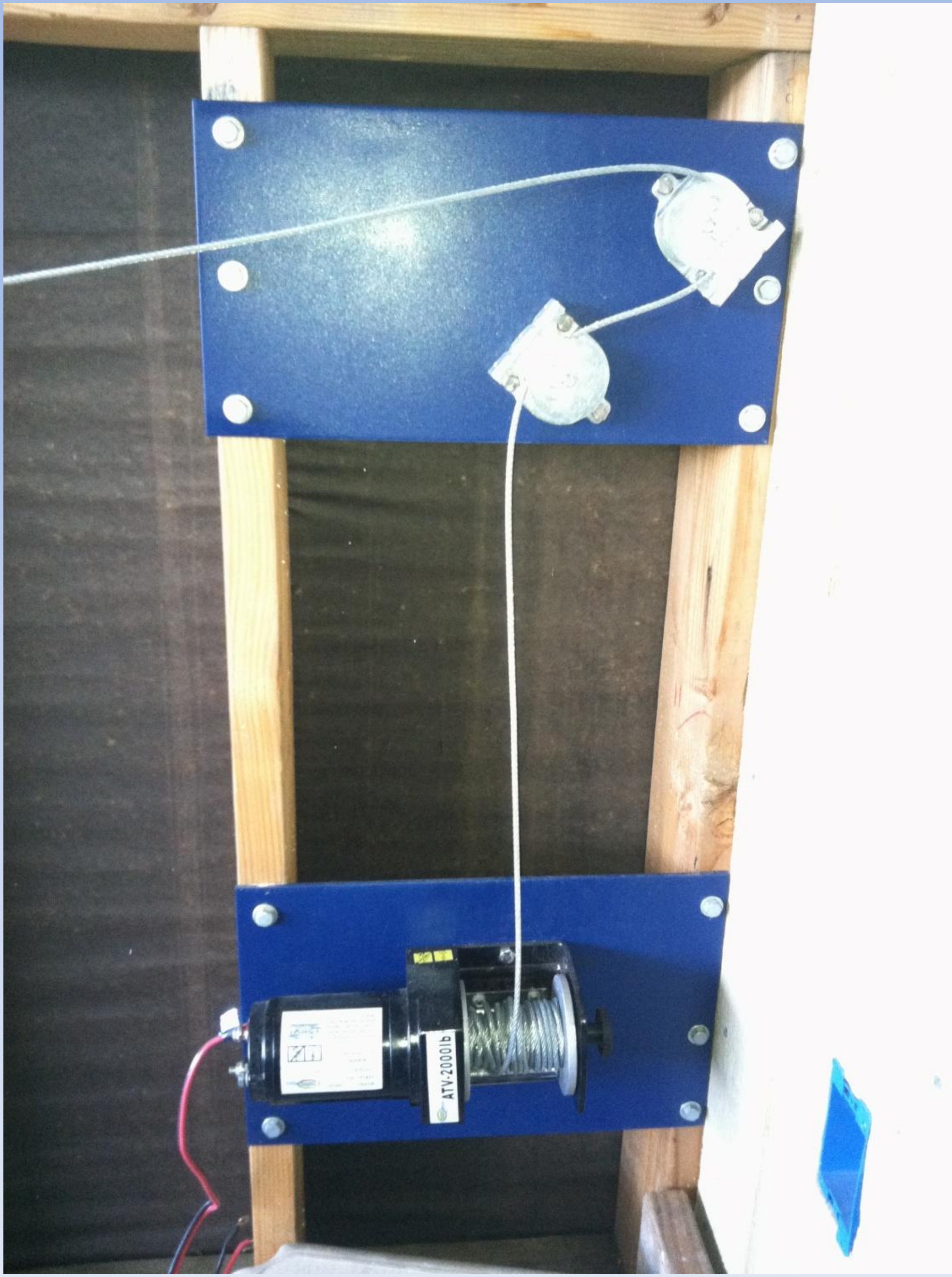
- At the end of 2009 or beginning of 2010, my Anza observatory slab was poured.
  - Observatory completed around March 2010.
  - Moved 20” StarSplitter telescope in shortly thereafter.





OCA Anza Observatory Plans

OCA Anza Observatory Build Pictures



Battery Operated Roof Opener using ATV Winch

Cable had to be re-directed thru a different pulley at far end of observatory to close

20” StarSplitter Dobsonian in Observatory

Installed ServoCat system with encoders to have a Go-to Dob

Argo Navis

Servos

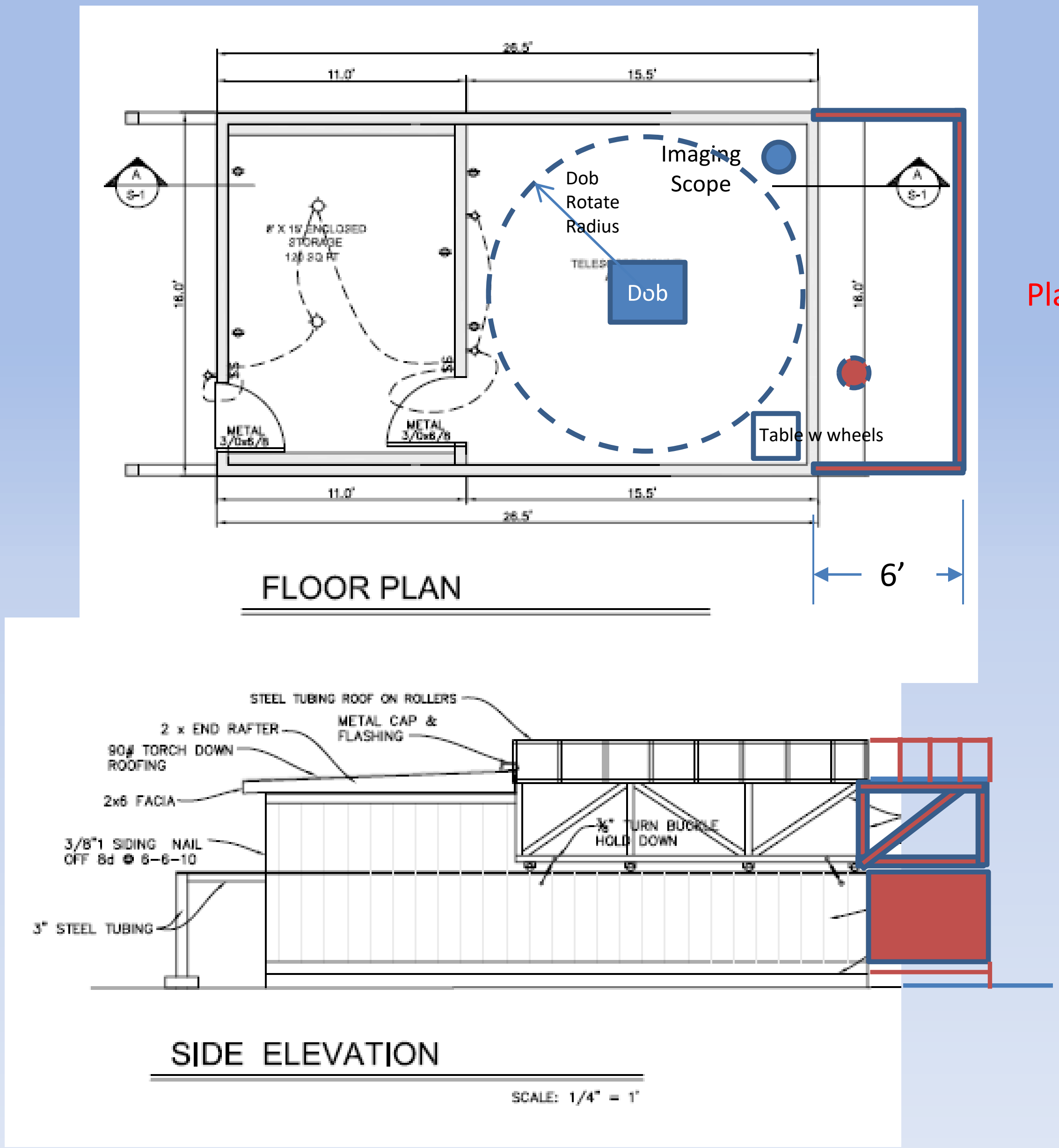
Includes 10k/32k optical encoders

Front view showing mounted ServoCat

2013 Installed First Astrophotography Equipment

- Ioptron iEQ-45 Mount
- WO 81 3 element Gran Turismo APO
- Borg 50 w SBIG STi
- Moonlite Focuser w RoboFocus Controller
- SBIG ST-8300C

Observatory Modifications in 2015



Installed push button Roof opener/closer

Power Outage Backup

1) Disengage gear
2) Battery Operated Roof Opener using ATV Winch (original method)

Installed Pier, Astro-Physics 1200 GTO Mount and RC12 in 2015

- Used SBIG ST-8300c with OAG
- Added SBIG STF-8300m with filter wheel in 2016

Equipment List Moving to DSW shown on right

- AP-1200 GTO mount CP4 w Radio Shack 10A, 12v Power Supply
- Pegasus Ultimate USB/Power Hub with 20A, 13.8v Astron Power Supply derated to 12.8v

<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 controller
- SBIG ST-8300c with OAG
- SBIG STi guide camera

Planetary Scope

- Ioptron iEQ-45 Mount
- Intes MK-66 150mm Mak-Cassegrain fl=1800mm w 1.6x Barlow
- Borg 50 w ZWO ASI-174
- Moonlite Focuser w Robofocus Controller
- ZWO ASI-290

Solar Scope (not shown)

- Coronado SolarMax II 60 Solar Telescope modified for moonlite focuser w robofocus controller
- ZWO ASI-174

My Adventures to Remote Observing

Reasons to go Remote in a different observatory:

1) Limited imaging hours per year
    - Only 8-9 months of good weather around new Moon.
        - Average 8.7 hours per day between astronomical Twilight

Days Stayed	1	2	3	4
Total Hours	78.3	156.6	234.9	313.2

Assume 9 months good weather a year

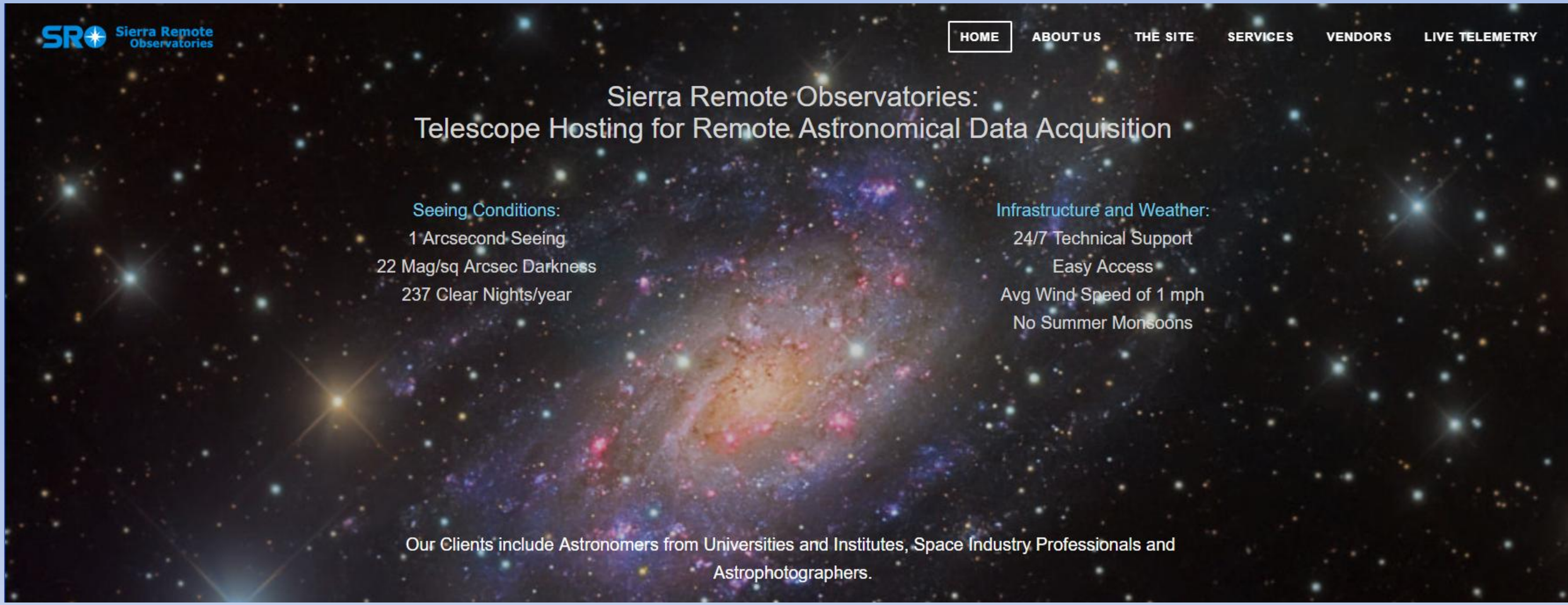
2) Internet bandwidth not sufficient to remote at Anza

3) South doors need to be automated to open/close roof

4) Roof open/close must be coordinated with telescope motion

5) Future health may not be sufficient to go to Anza

6) Seeing is OK, but not great



Sierra Remote Observatories is uniquely situated on the western edge of the Sierra Nevada Mountains, about 50 miles South of Yosemite National Park. It is unique in having excellent darkness and seeing conditions while also being relatively close to a major metropolitan area, allowing for easy access. Our site has:

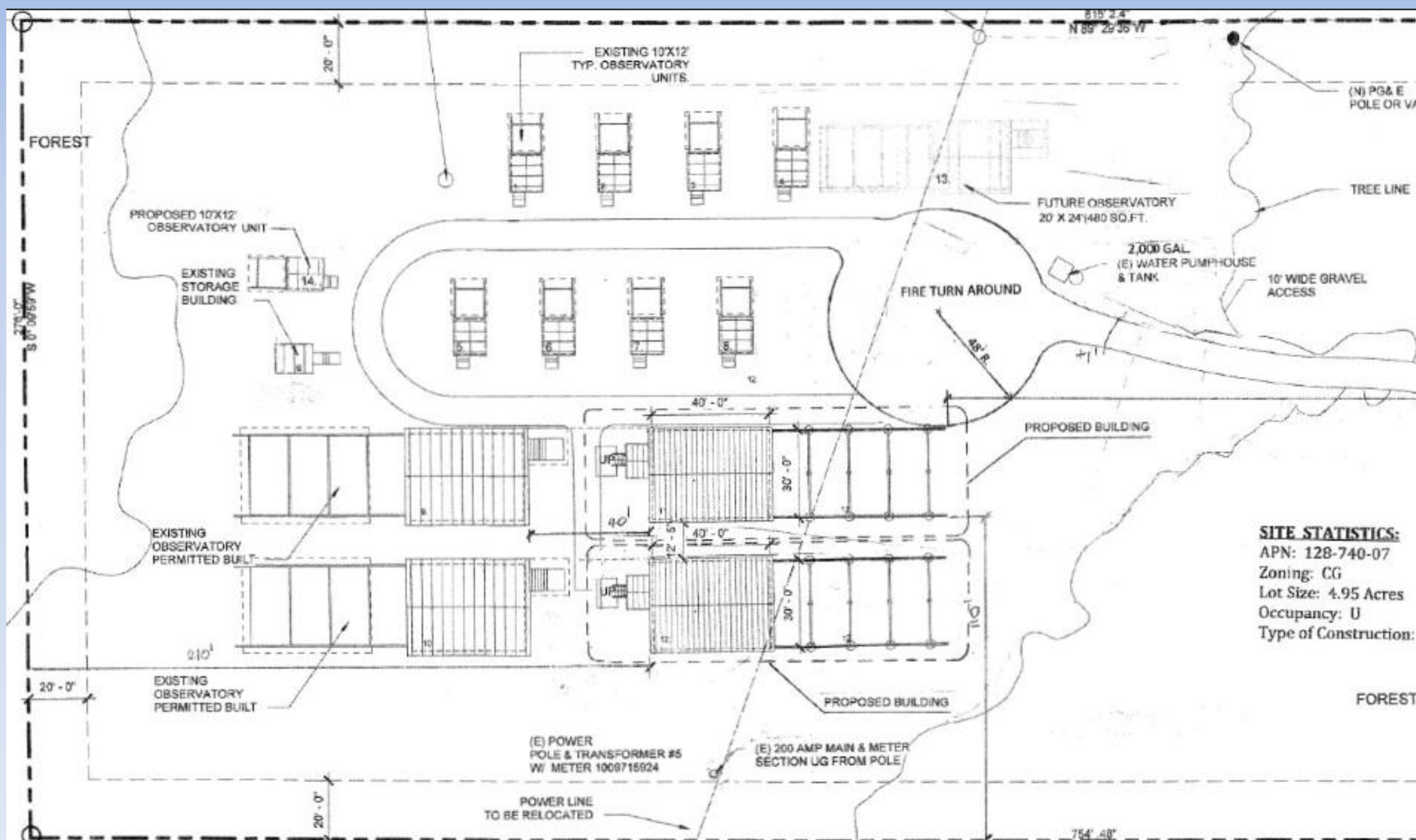
Services & Support

We have quick and responsive on-site technical services:

- Knowledgeable, full-time service technicians are on-site.
- 24/7 technical support available.
- Two hours per month of free support provided.
- Additional support can be purchased.
- Many back-up parts are stocked on-site.
- Parts can be delivered overnight.
- In-house machining services are available.
- We assist with installations.
- Crane services are available.

$1,500/month, 4,610 foot elevation,
640 miles round trip


SRO Sierra Remote Observatories
HOME
ABOUT US
THE SITE
SERVICES
VENDORS
LIVE TELEMETRY


N 89° 29' 36" W
20' - 0"
EXISTING 10'X12' TYP. OBSERVATORY UNITS
(N) PG& E POLE OR VAU
FOREST
13.
FUTURE OBSERVATORY 20' X 24'(480 SQ.FT.
TREE LINE
PROPOSED 10'X12' OBSERVATORY UNIT
2,000 GAL. (E) WATER PUMPHOUSE & TANK
EXISTING STORAGE BUILDING
14.
FIRE TURN AROUND
10' WIDE GRAVEL ACCESS
276'-0"
45' R.
40' - 0"
PROPOSED BUILDING
30' - 0"
40'
12' - 5"
EXISTING OBSERVATORY PERMITTED BUILT
SITE STATISTICS:
APN: 128-740-07
Zoning: CG
Lot Size: 4.95 Acres
Occupancy: U
Type of Construction:
20' - 0"
EXISTING OBSERVATORY PERMITTED BUILT
PROPOSED BUILDING
FOREST
(E) POWER POLE & TRANSFORMER #5 W/ METER 1009715924
(E) 200 AMP MAIN & METER SECTION UG FROM POLE
POWER LINE TO BE RELOCATED
754'.48'
S 89° 29' 36" E

$1,200 a month, 7,300 foot elevation, 1,700 miles round trip



New Mexico Skies

What makes New Mexico Skies the best remote observatory site on the planet?

Dark Skies:

There are many variables that impact the quality of your night sky observing. We believe that New Mexico Skies has an exceptional set of sky conditions that will take your breath away.

The "dark" at New Mexico Skies: Our skies are dark! New Mexico Skies is located 16 miles from the "nearby" village of Cloudcroft (population 592). We are 32 miles from Alamogordo, New Mexico, the Otero County seat, which has fewer than 40,000 residents and is located on the other side of the mountain ridge from us. The nearest big city is El Paso, Texas (100+ miles) and it is two mountain ranges away.

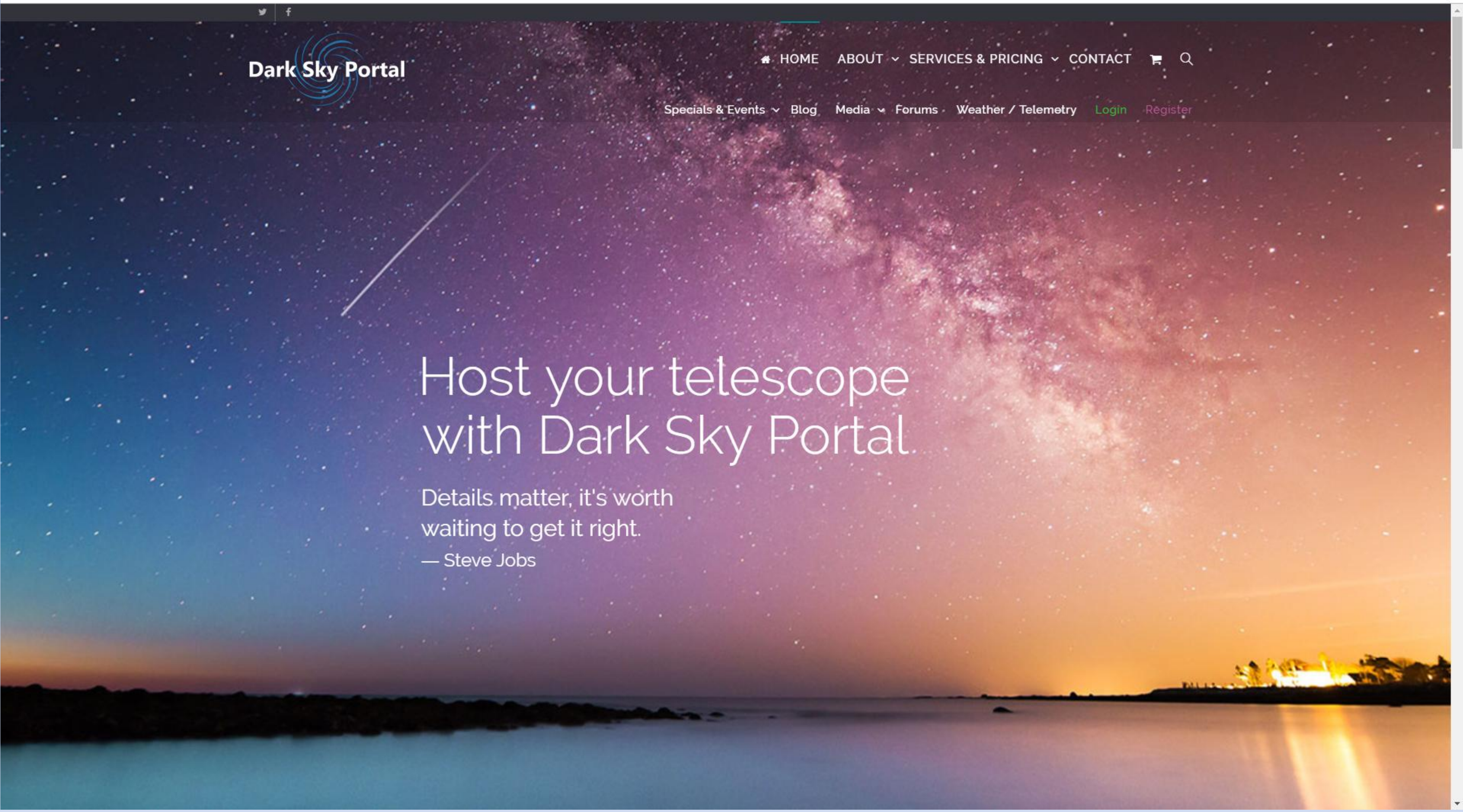
The "transparency" of our skies is phenomenal. Our 7300' altitude puts you well above most of the atmospheric borne pollution and particulate matter. The Sacramento Mountains are on the high desert and our skies benefit from the clean, dry air associated with desert environments. Fog is very rare. Airborne pollen content is usually low.

Tech Support:

Full machine shop, electronics shop and 24/7 on-site tech personel. New Mexico Skies is the only authorized repair shop for Bisque Paramount boards. If you need a part modified or built, we can generally do it here. Need a repair to your mount, computer parts; we keep most of what you may need here in stock. Along with on-site personel this means less down time for you.

Experience:

Mike and Lynn Rice, proprietors of New Mexico Skies, tested the first Software Bisque Paramount at their winter bush observatory in Alaska, some fourteen years ago. The first Student Telescope Network iBisque Internet imaging with just a browser began here and we never looked back. The field knowledge and experience available at New Mexico Skies is exceptional. At present we keep some 50 robotic telescope systems operating at our Northern and Southern Hemisphere locations. Details are available upon request.



4,200 foot elevation, 1,250 miles round trip

Monthly rate of $750 for Shared Hosting.
Monthly rate of $1000 for Private Hosting.

- A shared 2 Yr contract is $14,400 (20% discount) or 1 Yr contract for $8,100 (10% discount)
  A private 2 Yr contract is $19,200 (20% discount) or 1 Yr contract for $10,800 (10% discount)
- At present we are also offering an ‘Early Bird Signup’ incentive where we add an extra month free per year of contract. i.e. 13 months or 26 months.

http://www.remoteobservatories.com

$400-500 a month, 3,592 foot elevation, 1,050 miles round trip

What is SKYPi Remote Observatory?

SKYPi Observatory is dedicated to providing a superb remote imaging environment for the discriminating astrophotographer.

An Overview of SKYPi Remote Observatory

The observatory was conceived as an installation by which I could retire and enjoy observing and imaging in the finest sky within reasonable distance from my present home in Mesa, Az.

Pie Town, New Mexico is the location; population approximately 200. It is arguably among the darkest sky sites in the lower 48 states. There are many other advantages that come along with this site. As I began planning the observatory, I realized that sharing and hosting the site was a natural evolution for it. The goal is to make remote observing accessible and more affordable to the astronomy community. Paying more is not always better.

Listed below are advantages that have been shared or experienced over the past six years.

Advantages:

- Bortle Dark Sky Scale rating = 1.
- Optimal Seeing conditions; many times under 1.5 arc seconds.
- High 7,800 foot transparency.
- Early evening ground and sky energy dissipation.
- Low tree height providing wide horizon views.
- Well distributed vegetation offering protection from potentially high winds and dust.
- Lower potential fire hazard from wide vegetation dispersion.
- Low annual average snow fall allowing nearly full time access.
- Temperature extremes within tolerable limits for electronic and human function.
- The security of an attended subdivision.
- Very close emergency services. Pie Town has a highly dedicated, well trained fire department.
- Community CC&R's that protect the night sky by paralleling International Dark Sky Association recommendations.
- Subdivision management concerned with dark sky related issues and participates in protection of the pristine environment shared by astronomers and citizens.
- Other like-minded astronomers and citizens within the community that communicate and support activities related to maintaining this precious dark sky resource.

$650-$750/month, 7,800 foot elevation, 1,354 miles round trip

PIER LEASE INFO

Our mission is to make remote hosting affordable to a larger portion of the astronomy community. SKYPi provides exceptional service and support with rental of a pier for remote hosting at the best price possible….
$650 – 750 per month.

Want to team up with another astronomer to share the cost? No problem!

Items and services that SkyPi will provide:

12″ or 16″ diameter concrete pier with a 1″ aluminum upper plate, machine drilled for your mounts' bolt pattern.

Electrical power:

- 20+ amp, CGFI Circuit protection
- Digital Loggers remote switching 10 outlet AC power control.
- 1500Va Battery Backup.

Internet access :

- Secure network and network resources.

Password protected access to all video surveillance.

Emergency services will be dealt with immediately.

Regular equipment maintenance at no additional charge.

Urgent services are taken care of within 24 hours (call/text or e-mail).

- A technician and other personnel are available for technical assistance. We are available for assistance with items such as T-point modeling, changing cameras or shipping your equipment for any needed repairs. If issues require staff assistance due to operator error outside of or beyond normal business hours there **may** be a charge of $50 per hour.

Live sensor tower telemetry (check the website for details).

Locked gate security to the site.

In the event you are not available to bring your equipment to the site it can be shipped to our residence in Mesa, Az. We will transport to the site and disposition it as you desire, (set up or store for your arrival).

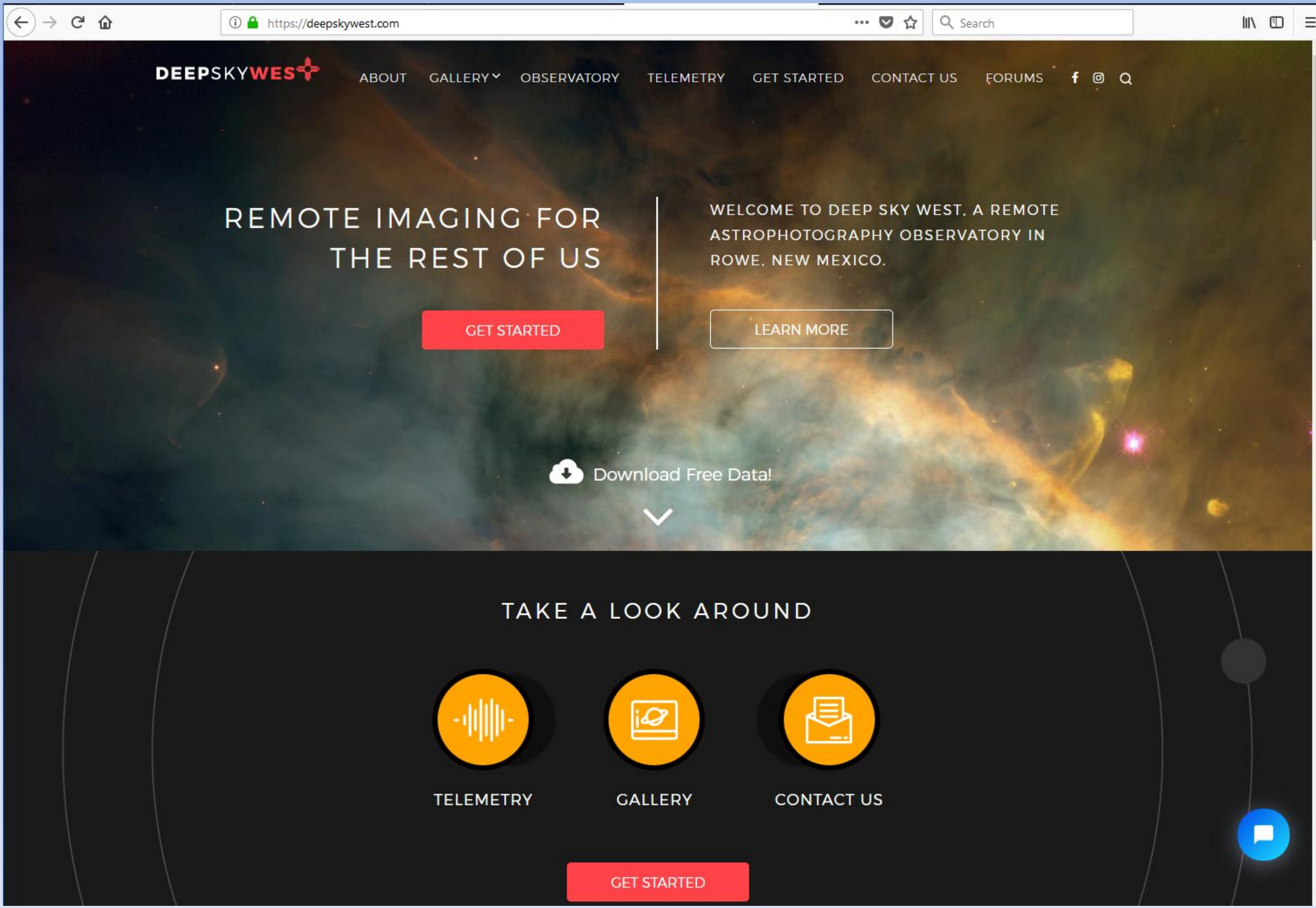
Observatory Features:

- High reliability observatory roof function:
- 2ea, 28″ hi, 12″ dia. top, 24″ dia. x 36″dpth. base, steel reinforced and anchored 3Kpsi concrete piers. 7′ separation.
- Design 9ft roof clearance that eliminates the possibility of impact with observing equipment.
- Manual user roof function override.
- Continuous weather monitoring performs roof closure when potential detrimental weather situations arise.
- Software interface free, position based, roof open/close function.
- SMS/text roof position/weather condition alerting.
- SMS/text power failure alerting.
- Internal and external video redundancy of observatory roof position, real time sky conditions, and security verification.
- Surge, lightning, power fail protection with Smart UPS systems on pier and observatory control.
- 24 hour emergency site service provided by a dedicated, reachable, well equipped and competent technician.
- Weekly on site/observatory maintenance, inspection, and testing.
- Satellite provided internet access supplies up to 15mb **v**, 3mb **^** .
- Friendly, responsive, experienced service.

The remote nature of the system demands success. After all, we can all imagine, and some experience, the sinking feeling of watching rain or snow falling unimpeded down on all that expensive equipment we gave our left and right arm up for. We've acquired the goal and can safely say, "Oh well", to the rain gods; ready when the inevitable clearing comes. At SkyPi Remote Observatory the mission is to promote the successful achievement of astronomical pursuits above all other aspirations.

Clear Skies,

John Evelan



$700/month, 7,400 foot elevation, 1,800 miles round trip

Before comparing Remote Observing Sites, need to define

1) Sky Brightness,
2) Transparency
3) Seeing

Zenith Sky Brightness Magnitude Definition

Light pollution is the alteration of night natural lighting levels caused by anthropogenic sources of light ([1]). Natural lighting levels are governed by natural celestial sources, mainly the Moon, natural atmospheric emission (airglow), the stars and the Milky Way, and zodiacal light. During moonless nights, the luminance of the clear sky background far from the Milky Way and zodiacal light is about 22 magnitude per square arcsecond (mag/arcsec^2) in the Johnson-Cousins V-band ([2]), equivalent to 1.7×10^{-4} cd/m^2.

We chose 22.0 mag/arcsec^2, corresponding to 174 µcd/m^2 (0.174 mcd/m^2), as a typical brightness of the night sky background during solar minimum activity, excluding stars brighter than magnitude 7, away from Milky Way and from Gegenschein and zodiacal light.

http://advances.sciencemag.org/content/2/6/e1600377.full

Conditions at Zenith			
Color	Artificial / Natural Sky Brightness	Sky Brightness mags / sq arcsec V Band	Bortle Scale approx
	< 0.01	22.00 to 21.99	1
	0.01 to 0.06	21.99 to 21.93	2
	0.06 to 0.11	21.93 to 21.89	2
	0.11 to 0.19	21.89 to 21.81	3
	0.19 to 0.33	21.81 to 21.69	3
	0.33 to 0.58	21.69 to 21.51	4
	0.58 to 1.00	21.51 to 21.25	4
	1.00 to 1.73	21.25 to 20.91	4.5
	1.73 to 3.00	20.91 to 20.49	4.5
	3.00 to 5.20	20.49 to 20.02	5
	5.20 to 9.00	20.02 to 19.50	5
	9.00 to 15.59	19.50 to 18.95	6
	15.59 to 27.00	18.95 to 18.38	7
	27.0 to 46.77	18.38 to 17.80	8
	>46.77	>17.80	9

Bortle Dark Sky Seeing Definition

Number Code	Map Color Code	Label	Sky Mag.
1		excellent dark sky	22.00–21.99
2		average dark sky	21.99–21.89
3		rural sky	21.89–21.69
4		rural/suburban transition	21.69–20.49
5		suburban	20.49–19.50
6		bright suburban	19.50–18.94
7		suburban/urban transition	18.94–18.38
8		city sky	< 18.38
9		inner city sky	.

https://www.handprint.com/ASTRO/bortle.html

http://www.cleardarksky.com/lp/OclaFLlp.html

Bortle Dark Sky Seeing Definition Description (continued)

Number Code	**Map Color Code**	**Label**	**Sky Mag.**	**Naked Eye Limit Mag.**	***320mm Limit Mag.***	***M33 Visible?***	***M31 Visible?***	**Central Galaxy Visible?**	**Zodiacal Light Visible?**	**Light Pollution**	**Clouds**	**Ground Objects**
1	Black	excellent dark sky	22.00–21.99	≥ 7.5	> 17	obvious		casts shadows	striking	airglow apparent		visible only as sihouettes
2	Dark Grey	average dark sky	21.99–21.89	7.0–7.49	16.5	easy with Direct Vision		Appears Hightly structured	Bright, faint Yellow color	airglow faint	Dark everywhere	Large near objects vague
3	Blue	Rural sky	21.89-21.69	6.5-6.99	16	easy with averted vision		complex structure	Obvious	LP on horizon	Dark overhead	Large distant objects vague
4	Green	Rural/Suburban	21.69-20.49	6-6.49	15.5	difficult with averted vision	Obvious	only large structures	Halfway to zenith	Low LP	Lit in distance	Distant large objects distinct
5	Yellow	Suburban	20.49-19.5	5.5-5.99	14.5-15		easy with direct vision	washed out	faint	Encircling LP	Brighter than sky	
6	Orange	Bright Suburban	19.5-18.94	5-5.49	14-14.5		easy with averted vision	visible only near Zenith		LP to 35 deg	Fairly bright	Small close objects distinct
7	Red	Suburban/Urban	18.94-18.38	4.5-4.99	14		difficult with averted vision	invisible		LP to Zenith	Brillantly lit	
8	White	City Sky	<18.38	4-4.49	13					Bright to 35 deg		Headlines legible
9	White	inner City Sky		<= 4						Bright at zenith		

https://www.handprint.com/ASTRO/bortle.html

Transparency and Seeing Definitions

Transparency is the opacity of the atmosphere, or how clear it is. Moisture and humidity lower the transparency, as does smoke or other kinds of pollution. It's not entirely unlike light pollution in that it washes out the fainter details of astronomical targets. In fact, poor transparency typically makes light pollution worse because it scatters the light around instead of letting it escape into space away from your cameras and optics.

- Transparency usually gets better with altitude, because you're looking through less air. That's why high altitudes are prized for observatories and star parties.
- Transparency is also usually very good after a rainstorm has come through to clear all of the particulates out of the air.

Seeing, on the other hand, is a measure of *atmospheric turbulence*. We know that if we take a photo of a fast-moving subject, such as at a sporting event, with a low shutter speed, we'll get a blurry image. So what happens when you have to take a very long dark-sky photo and the stars are jumping all about due to atmospheric turbulence? That's right, blurry stars and deep sky objects.

- Seeing is usually measured in arcseconds, an angular measure that describes distance on the celestial sphere. If the seeing was 4 arcseconds, it means the stars can be expected to dance around inside a circle with a diameter of 4 arcseconds. Seeing of 1 arcsecond is 4 times better and would then yield much smaller, less bloated stars, as well as finer detail on deep sky objects.
- Seeing is typically better in places where the geography is very flat. The air masses moving over the land encounter few obstacles and flow more smoothly (sometimes called a *laminar flow*).
- After a front comes through (often accompanied by some rainstorms), the air becomes turbulent for a day or so afterwards.
- If mountains are good for transparency, but poor for seeing, why are so many observatories located up on big mountains? Because as they say... less is more. Less air at high altitudes yields better transparency as I've said, but at the highest mountains you are also above much of the turbulent air, which mitigates the effects on seeing.

https://www.skyandtelescope.com/astronomy-blogs/imaging-foundations-richard-wright/seeing-vs-transparency-difference/

Clear Skies Transparency Nomenclature

Observing deep sky objects such as faint galaxies and nebulae requires excellent sky transparency.

- Astronomers evaluate sky transparency with the faintest star visible to the unaided eye.
- In semi-desertic regions such as Arizona, one can see stars as faint as 6.5-7.2 magnitude. At mid-latitudes and in the more humid eastern regions. most of the time sky transparency is limited to the 5.5-6.5 range in the countryside.
- Sky transparency also varies with airmass type. With a humid airmass the transparency is reduced significantly. With a continental airmass from the arctic, relatively cold and dry conditions prevail, allowing the sky transparency to be at times be as good as in the semi-desertic regions.
- Moisture is the only element affecting sky transparency which can be both measured and forecast all across the globe. It is often the most important factor in reducing sky transparency. A muggy summer day with a whitish sky is the best example of this moisture effect.
- Industrial pollutants and light pollution affect the sky transparency as well, but only locally. Aerosols such as volcanic ash, pollen, sea salt and smoke from forest fires also contribute to reduced sky transparency. The same can be said for **auroras**. None of these factors is integrated into our transparency forecast images.
- So the experimental forecast is only an integration of moisture throughout the air column with a distribution emphasizing the humidity near the surface and near the tropopause. The quality of the sky transparency is represented by 4 colour levels. The darkest shade of blue represents the best sky transparency. The white zones are areas where the weather models forecast clouds.

Dark blue: excellent sky transparency.
Medium blue: above average sky transparency.
Light blue: average sky transparency.
Pale blue: poor sky transparency.
Grey: very poor transparency.
White: cloudy sky.

https://weather.gc.ca/astro/transparence_e.html

Pickering Seeing Scale

Harvard College Observatory's William H. Pickering (1858-1938). Pickering used a 5-inch refractor. His comments about diffraction disks and rings will have to be modified for larger or smaller instruments, but they're a starting point:

1 — Star image is usually about twice the diameter of the third diffraction ring if the ring could be seen; star image 13 arcseconds (13") in diameter.
2 — Image occasionally twice the diameter of the third ring (13").
3 — Image about the same diameter as the third ring (6.7"), and brighter at the center.
4 — The central Airy diffraction disk often visible; arcs of diffraction rings sometimes seen on brighter stars.
5 — Airy disk always visible; arcs frequently seen on brighter stars.
6 — Airy disk always visible; short arcs constantly seen.
7 — Disk sometimes sharply defined; diffraction rings seen as long arcs or complete circles.
8 — Disk always sharply defined; rings seen as long arcs or complete circles, but always in motion.
9 — The inner diffraction ring is stationary. Outer rings momentarily stationary.
10 — The complete diffraction pattern is stationary.

On this scale 1 to 3 is considered very bad, 4 to 5 poor, 6 to 7 good, and 8 to 10 excellent.

https://www.skyandtelescope.com/astronomy-equipment/a-scale-of-seeing/

Clear Skies Seeing Nomenclature

Professional astronomers and more advanced astro-amateurs evaluate the seeing with a scale 1-10. Through a telescope, they measure the star diameter which usually ranges from bad seeing at 5-8 arcsec to excellent seeing at 0.5-0.2 arcsec.

- Astro-amateurs, can also use a qualitative way to measure the seeing.
- They look through their telescope at the zenith for a 2-3 magnitude star at about 30-40X per inch diameter (300-400x for a 10 inch telescope) and from the look of the diffraction pattern they estimate the seeing on a scale I-V.

The seeing can be rated through astro-amateur telescopes with the following guidance	
Categories	Seeing in arc-second
V	Perfect motionless diffraction pattern
IV	Light undulations across diffraction rings
III	Central disc deformations. Broken diffraction rings
II	Important eddy streams in the central disc. Missing or partly missing diffraction rings
I	Boiling image without any sign of diffraction pattern

https://weather.gc.ca/astro/seeing_e.html

Clear Skies Seeing Nomenclature (continued)

- Of course, the diffraction pattern diameter is related to the aperture of the telescope. The diffraction pattern of a 4 inch telescope is twice as large as for an 8 inch instrument. So the seeing rating with this method will depend of the diameter of the telescope. An astro-amateur rating the seeing at 4/5 with a 6 inch telescope will certainly appear as a 3/5 with a 12-14 inch optical instrument. So it is important to understand or be aware of this difference.
- This forecast is based on the data accumulated with 11-14 inch telescopes during a four year period, so this study was done with the average modern astro-amateur telescope diameter. Astro-amateurs owning a smaller telescope may find the following forecast a bit pessimistic but you can adjust the colour index to your observations. Amateurs owning an 8-20 inch telescope should find this product quite useful and when the forecast shows a seeing 5/5 over an area… it should be the best planetary conditions for any telescope diameter.

The seeing can be expressed in arc-second for each catogories

Categories	Seeing in arc-second
V	< 0.4"
IV	~ 0.4-0.9"
III	~ 1.0-2.0"
II	~ 3.0-4."
I	> 4"

The quality of the seeing is represented by 5 colour levels.The darkest shade of blue represents the best seeing and the grey colour the worst seeing conditions. The white zones are areas where the weather model forecast clouds.

Planetary Seeing

Introduction.

Astronomical seeing scales such as those of Antoniadi and Pickering are well known to visual observers though for modern Planetary imagers using CCDs and webcams they aren't especially convenient to use since the vast majority of the time such observers are watching the Planetary image on screen.

Having many years of experience in Planetary imaging and having taken thousands of video sequences i have selected five sequences by which observers can gauge the prevailing seeing conditions. I decided Jupiter as the object for references as it is probably the most popular target among Planetary imagers. All example videos were taken with my C14 Telescope and SKYnyx camera. All captures were taken through a Green Light filter. A five point scale was decided upon comprising the following:

5. Excellent Seeing - A solid stable disk with good contrast. Minor Planetary details are held for long periods. No significant undulation or fuzziness.

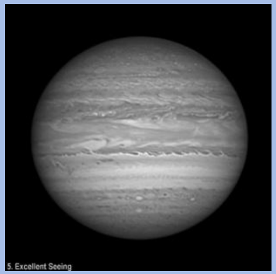
4. Good Seeing - A mostly solid stable disk with good contrast. Minor details are frequently seen though not held for long periods.

3. Fair Seeing - Slight or moderate undulation or fuzziness. Reasonable contrast. Minor planetary details occasionally seen.

2. Poor - Very Poor seeing - Severe undulations or fuzziness. Poor contrast. Large scale detail poorly defined. Minor details invisible.

1. Extremely Poor seeing - Severe undulations or fuzziness. Very poor contrast. Little detail visible.

https://youtu.be/RavpiN0Axj4



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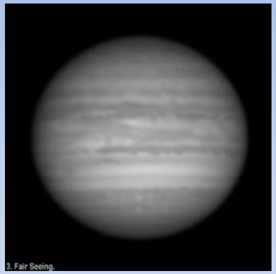
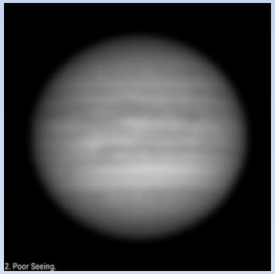
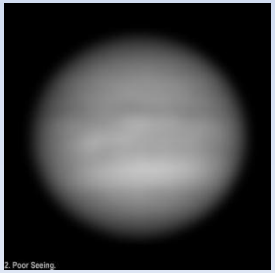


https://youtu.be/-tiIFhNVPT0



https://youtu.be/w-2F3Db6HKg



http://www.damianpeach.com/seeingscale.htm

Remote Hosting Observatory Site Comparison

	OCA Anza	Sierra Remote Observatories	Dark Skies Portal	New Mexico Skies	Deep Sky West	San Pedro Valley Observatory	Sky PI
Latitude (deg)	33.482 N	37.07 N	32.119 N	32.903 N	35.331 N	31.941 N	34.304 N
Longitude (deg)	116.722 W	119.413 W	108.925 W	105.529 W	105.654 W	110.258 W	108.137 W
Altitude (ft)	4281	4600	4200	7300	7200	3592	7717
Near	Anza, CA	Auberry, CA	Animas, NM	Mayhill, NM	Rowe, NM	Benson, AZ	PI Town, NM
Round Trip (mi)	160	640	1250	1700	1800	1018/1084	1344
First Light	NA	2007	2018	<2009	2008	<2015	~2012
SQM (mag/arc-sec2)	21.56	21.78	21.99	21.96	21.95	21.66	22
Brightness (mcd/m2)	0.257	0.209	0.173	0.177	0.18	0.235	0.172
Artif. Brightness (µcm/m2)	86.1	38.2	2.17	6	8.55	63.4	0.581
Ratio	0.503	0.223	0.0127	0.0351	0.05	0.371	0.0034
Bortle class	4	3	1	2	2	4	1
Min/Ave/Max Cloud Cover (clear)	54-65-88	47-64-89	28-64-80	40-65-77	42-60-73	33-67-84	34-61-74
Ave Cloud Cover (10%)	5	5	6	7	7	6	7
Ave Cloud Cover (20%)	3	3	5	5	5	4	5
Min/Ave/Max Transparency (Transparent)	14-30-67	2-14-41	1-26-50	1-19-29	1-14-28	1-27-55	1-15-35
Ave Transparency (Above Ave)	18-26-35	14-26-44	6-28-37	9-27-39	9-26-39	4-28-39	5-28-38
Ave Transparency (Average)	13	23	15	19	21	14	21
Min/Ave/Max Seeing (Excellent)	5-11-27	5-13-23	1-3-12	1-4-18	1-2-7	1-5-18	1-4-13
Ave Seeing (Good)	34	35	30	10	18	36	25
Ave Seeing (Average)	31	31	42	27	35	39	35
Clear Nights Predicted (ave)	237	233	233	237	219	244	223
Min/Max Night Temperatures	~25-85						
24/7 Technical Support	No	Yes, 2 hrs/month	Yes	Yes	No, On-Call	Limited free	No, On-Call
Machine Shop	No	Yes	Unknown	Yes	No	No	No
24/7 Security	No	24/7 Personnel	Yes	Yes	locked gate/building, security Cameras with motion detection	Yes	No?
On-site Accomodations	Yes	Don't think so	RV	Yes	No	No	No
Telescope Ext Camera Provided	No	Yes		Yes?	Yes	All-Sky	Yes
Weather/Roof Control Provided	No	Yes		Yes	Yes-autonomous	Roof-Web relay, Web-site Weather	Yes
High Speed Internet	No	Yes	Yes	Yes	Yes	Yes	Satellite
Roof open/close at any scope position	No				Yes	No	Yes
Availability	No	New Building-started Nov 2018			end of 2018	Now	Now
Monthly Cost ($)	43.33	1500	750 Shared 1000 Private 10%/20% discount if paid 1yr/2yr upfront	1200 (up to 14") 1750 (up to 16")	700	500 Private 400 Shared	650-750

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

No Observatory/Observatory/Remote Observatory Cost Comparison

- The cost comparison can be done in at least two ways.   Total Upfront Cost and Cost per imaging hour.
  - Total upfront cost is easy and simple
    - Building an observatory is more expensive than operating with no observatory.   And adding a warming room is even more expensive.
    - A remote observatory is less expensive at the beginning, but within a short time it will more expensive than an observatory. And over a long term the cost would have been sufficient to build several observatories.
  - Cost per imaging hour looks at it from an operational cost point-of-view
    - The more imaging hours used, the lower the cost
    - From one perspective, this is just how to justify spending a lot more money!
  - This comparison is similar to comparing the cost of buying or leasing a car.   It is always cheaper to buy and keep the car until it dies, than lease a car for the same period of time.
    - The person who leases is willing to spend more money for the advantage of lower or no maintenance cost, less time in the shop, and getting a new car every few years.
    - The benefit for a remote observatory, is more available imaging hours that can be taken at the user preferred time while at home.   With only one or more longer trips per year at their choosing.

No Observatory/Observatory/Remote Observatory Cost Comparison
(continued)

- There is a lower cost solution to putting expensive equipment at a remote observatory
  - Remote Observatory Subscriptions
    - These subscriptions models can cost only $200-$600 a year and does not require telescope equipment.
      - Images are from top of the line telescope equipment, some times with a choice of aperture, focal length and camera.
    - Assuming $20,000 required for high end telescope/camera equipment, and with a cost of $600/year, the break even point would be 33.3 years. Building a $20,000 observatory with warming room for the high end equipment, the cost break even point is 66.6 years.
      - These subscription models provide the images to a subscriber after the telescope owner/operator takes the images.
      - So if not interested in buying, maintaining and operating a telescope and don't want to travel, the lowest cost option is to purchase a subscription.

- The following chart shows the cost per imaging hour comparison.

No Observatory/Observatory/Remote Observatory Cost Comparison (continued)

	Year/month
Hours per year/month	8766/731
2018 Astronomical Twilight hours	3188/266
2018 Ast Twilight + No Moon hours	1571/131
Average Ast Twilight hours/day	8.70
Average Ast Twilight + No Moon hours/day	4.32

@Anza - 12 New moon Weekends
With weather conditions, usually only get 8-9 weekends per year

		Equipment Only				Equipment + Observatory				Equipment + DSW Remote							Equipment + SRO Remote						
	Total Miles/round trip	200								1800							640						
	Gas Mileage (mpg)	20																					
	$/gal	$3.25																					
	Annual Trips	9								2							2						
	Ast Twilight Hrs/day ave	8.76																					
	Cost	$20,000.00				$45,000.00				$23,000.00							$23,000.00						
	Annual Fees	$50.00				$470.00				$8,400.00							$18,000.00						
	Days Stayed	1	2	3	4	1	2	3	4	1	2	3	4	NA	NA	NA	1	2	3	4	NA	NA	NA
	Total Hours	78.84	157.68	236.52	315.36	78.84	157.68	236.52	315.36	78.84	157.68	236.52	315.36	500	750	1000	78.84	157.68	236.52	315.36	500	750	1000
Years	1	$258.02	$129.01	$86.01	$64.51	$580.45	$290.22	$193.48	$145.11	$405.70	$202.85	$135.23	$101.42	$63.97	$42.65	$31.99	$527.46	$263.73	$175.82	$131.87	$83.17	$55.45	$41.59
	1.4	$185.54	$92.77	$61.85	$46.39	$417.37	$208.68	$139.12	$104.34	$322.34	$161.17	$107.45	$80.59	$50.83	$33.88	$25.41	$444.11	$222.05	$148.04	$111.03	$70.03	$46.68	$35.01
	3	$88.90	$44.45	$29.63	$22.23	$199.93	$99.97	$66.64	$49.98	$211.21	$105.60	$70.40	$52.80	$33.30	$22.20	$16.65	$332.97	$166.49	$110.99	$83.24	$52.50	$35.00	$26.25
	5	$55.08	$27.54	$18.36	$13.77	$123.83	$61.91	$41.28	$30.96	$172.31	$86.16	$57.44	$43.08	$27.17	$18.11	$13.59	$294.08	$147.04	$98.03	$73.52	$46.37	$30.91	$23.19
	6.5	$43.37	$21.69	$14.46	$10.84	$97.48	$48.74	$32.49	$24.37	$158.85	$79.42	$52.95	$39.71	$25.05	$16.70	$12.52	$280.61	$140.31	$93.54	$70.15	$44.25	$29.50	$22.12
	7.5	$38.17	$19.08	$12.72	$9.54	$85.77	$42.89	$28.59	$21.44	$152.86	$76.43	$50.95	$38.22	$24.10	$16.07	$12.05	$274.63	$137.31	$91.54	$68.66	$43.30	$28.87	$21.65
	10	$29.71	$14.86	$9.90	$7.43	$66.75	$33.37	$22.25	$16.69	$143.14	$71.57	$47.71	$35.78	$22.57	$15.05	$11.29	$264.90	$132.45	$88.30	$66.23	$41.77	$27.85	$20.89
	12	$25.48	$12.74	$8.49	$6.37	$57.24	$28.62	$19.08	$14.31	$138.28	$69.14	$46.09	$34.57	$21.80	$14.54	$10.90	$260.04	$130.02	$86.68	$65.01	$41.00	$27.34	$20.50
	15	$21.26	$10.63	$7.09	$5.31	$47.72	$23.86	$15.91	$11.93	$133.41	$66.71	$44.47	$33.35	$21.04	$14.02	$10.52	$255.18	$127.59	$85.06	$63.79	$40.24	$26.82	$20.12
	18	$18.44	$9.22	$6.15	$4.61	$41.38	$20.69	$13.79	$10.35	$130.17	$65.09	$43.39	$32.54	$20.53	$13.68	$10.26	$251.94	$125.97	$83.98	$62.98	$39.73	$26.48	$19.86
						Observing Hours/month				6.57	13.14	19.71	26.28	41.67	62.50	83.33	6.57	13.14	19.71	26.28	41.67	62.50	83.33
						Observing Hours/week				1.52	3.03	4.55	6.06	9.62	14.42	19.23	1.52	3.03	4.55	6.06	9.62	14.42	19.23

Cost Break even

- With the assumed starting cost + yearly fees, the lowest cost/hour option is no observatory
- An observatory with a warming room is double the cost/hour of no observatory
- With the DSW annual fees, and number of imaging hours less than those obtain if imaging at Anza, the cost/hour breakpoint is 3 years. With SRO annual fees, the cost/hour breakpoint is 1.4 years.
- Based on 750 imaging hours available with no moon (~ 60% clear night skies)
    - DSW cost/hour breakeven with an observatory occurs at 12 years, and 5 years with SRO annual fees
- Based on 1000 imaging hours available (750 hours no moon + 250 hours Narrow Band with moon) the breakeven point with an observatory occurs at 18 years with the DSW annual fees, and 7.5 years with SRO annual fees.

No Observatory/Observatory/Remote Observatory Cost Comparison (continued)

Conclusions

- This cost analysis didn't revealed anything surprising. Having an Observatory is a lot more expensive. Having a Remote observatory is also expensive and over time will be very expensive, but does allow more flexibility when to image and allows opportunity to increase the time imaging from any location. If cost is prohibited, than a remote observatory subscription may be better.

- The only conclusion that I got from this analysis is $700/month is the highest I am willing to pay for a remote observatory using my own equipment. This works out to about $10 per imaging hour which is about the same prorated cost per hour of having an observatory after 18 years.

- The benefits are getting 1000 annual imaging hours per year that I can choose when to image without leaving the house.
- The disadvantages is the cost and having to make a long road trip 1-2 times a year.

First steps to go to remote astrophotography

- Let's start by assuming you have high end astrophotography equipment using a hand controller for the mount (but have capability to be controlled by PC), manual focuser, a DSLR controlled by a wireless remote intervalometer, and a battery. You already have a PC for processing. You have been operating it for a while, and you would like to improve your image quality, be more automated, and eventually get an observatory with a warming room to get more and better sleep.
- So the first steps are to upgrade your equipment.
  1) DSLR to a cooled CCD or CMOS camera
     - A monochrome camera will need filter wheel and filters
  2) A guide camera with telescope or main telescope guiders (Off-axis guider,(OAG), Adaptive optics (OA), or On-axis guider (ONAG))
  3) Manual focuser to a PC controlled focuser with controller, and PC controller software
  4) Use ASCOM platform (Free)
  5) Use a Plate solver (Pinpoint)
  6) Imaging software package with planetarium program to control mount, focuser and camera.
     - Prism, Maxim DL, Sequence Generator Pro v3.0 with PHD2, The Sky, Etc.
     - Some of these packages come with a imaging script capability to automate obtaining image subs. The others will require purchase of an image script; CCD Commander or CCDAutoPilot, etc.

Next steps to go to remote astrophotography

- Once the previous steps have been completed and you have become acquainted with its use, than it may be time to think about going to an observatory










Typical Observatory Types Advantages/Disadvantages (no warming room)

Observatory Types	Advantages	Disadvantages
Rotating Dome	• Stray-light and wind protection for selected ~340 degrees of azimuth	• Single pier only
	• Telescope can be moved in any direction while roof closed	• Requires Roof motion to be corridinated with telescope motion
	• Can have 360 deg horizon viewing depending on pier height	• Can be expensive
	• Looks impressive	
Clam-shell	• Stray-light/wind protection with rotating clam-shell for selected 180 degrees of azimuth	•Multiple pier cabable for large diameters (also dependent on scope size)
	• Telescope can be moved in any direction while roof closed for single pier	• Fixed 180 degrees of azimuth stray-light/wind protection with non-rotating clam-shell
	• Can have 360 deg horizon viewing depending on pier height	• Can be expensive
	• Looks impressive	
Roll-off	• Can be less expensive than rotating dome or clam-shell	• Mininual stray-light and wind protection (depending on desired horizon elevation)
	• Multiple pier capable	• Observatory foot-print is larger than other types (when roof open)
	• Easy DIY Build	

Observatory Cost Examples

Technical Innovations

- 6 ft - $5,750
- 10 ft - $8,795
- 15ft - $19,750

AstroHaven

- 12.5ft – $33,950
- 16ft - $65,450

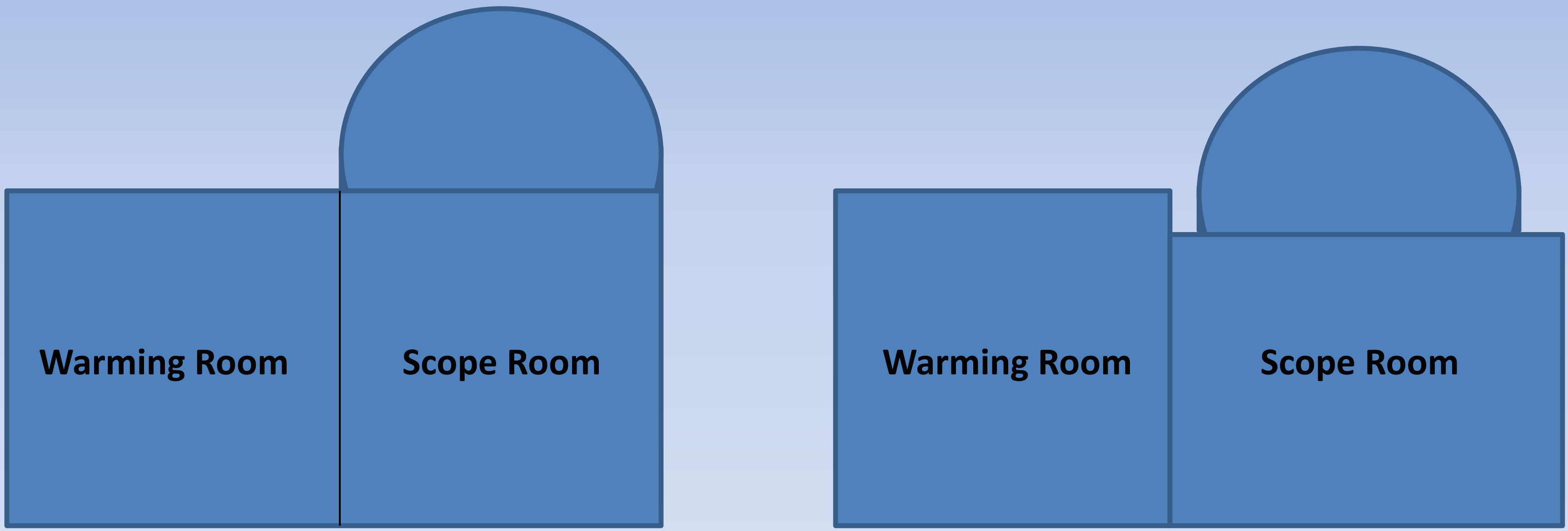
- Aphelion Domes
  - 7ft – $10,500 – 15,500
  - 12ft – $22,500 – 27,500

Pier-Tech

- 7’x7’x19” - $5,300
- 8’x8’x19” - $6,300
- 9’x9’x19” - $7,300
- 10’x10’x19” - $8,300

Adding a warming room to Rotating Dome or Clam-Shell

There are at least two obvious options; 1) Put the dome or clam-shell adjacent to the warming room but at a height above the warming room roof, or create a step down observatory adjacent to the warming room that is larger than the dome. The latter would put the dome opening or clam-shell skirt at the same height as the top of the warming roof.



With either option, a higher pier will be required which raises the telescope to a level that requires a ladder or a raised sub floor to be able to perform maintenance or changing of equipment

Next steps to go to remote astrophotography (continued)

Designing a Roll-off roof observatory

- The roll-off roof observatory is popular as it can be built for any number of piers from a single pier to many piers for a group observatory and usually can be built for a lower cost than other types.
- The major design decisions are 1) the number and spacing of piers, 2) the interior roof height, 3) the amount of horizon visibility versus wind/stray light protection, and 4) whether a warming room is to be attached.

The roll-off observatory can be as simple as a box with a door and a roof that can be open/close by hand. Although, with this example, it can be seen that the telescope can not see down to the horizon, but does have a little wind and stray light protection.

Next steps to go to remote astrophotography (continued)

Roll-off roof observatory (continued)

1) the number and spacing of piers

- The number of piers and the sizes of your telescopes in your observatory will define the majority of the observatory' footprint. Each telescope must have sufficient space to allow work around each telescope and also to not interfere with each other. The location of the piers with respect to the observatory walls will define the remaining observatory footprint to achieve the desired horizon view and/or wind/light protection.

2) the interior roof height

- The interior roof height can be as important as is needed. In small observatories as shown previously, interior roof height is only important for the telescope to fit underneath. Head height is fine after opening the roof. However, if you want to work on the telescope while in the observatory during daytime or during incumbent weather, having room to stand up and walk around the telescope may be desired? If you need to test the telescope while the roof is closed, is the interior roof height sufficient to slew the telescope? If you eventually automate the roof to open/close by the touch of a button, or get a remote observatory, do you have sufficient interior roof height to open and close the roof with no risk of hitting the scope for any position of the scope? The answers to these questions are up to you.

Next steps to go to remote astrophotography (continued)

Roll-off roof observatory(continued)

3) **the amount of horizon visibility versus wind/stray light protection**

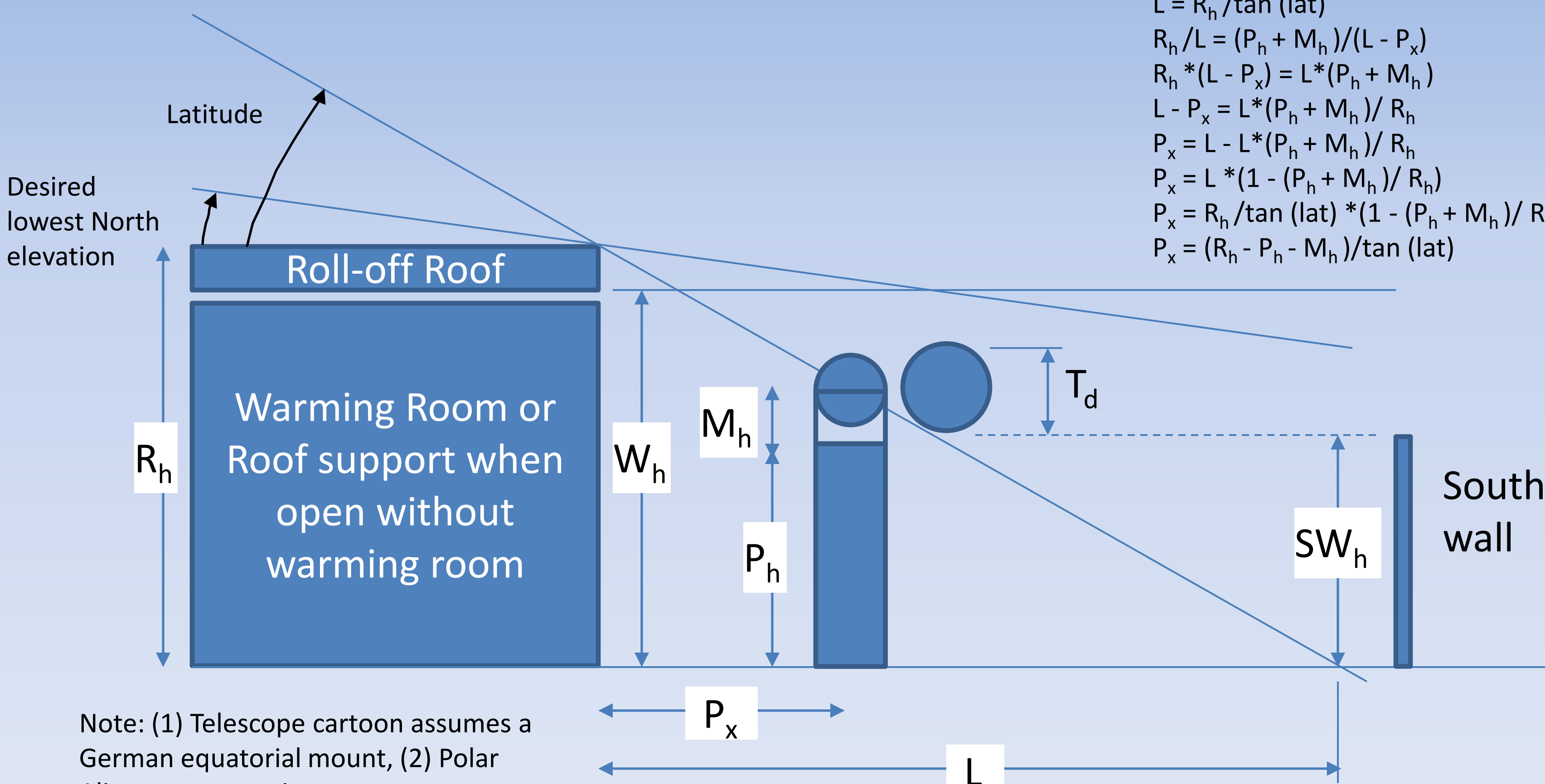
- This is one of the roll-off roof design compromises that must be made. The capability to see to the horizon, makes the telescope more susceptible to wind. To reduce the effects from the wind will compromise the telescope ability to see to the horizon. Although there are some tricks that can be done to allow the option to have wind protection but still have some horizon viewing in limited directions.
  - Tricks are
    1) Use South wall with a fold down door to allow horizon viewing and with capability to raise door for wind/stray light protection. The east/west wall could be sized to provide wind/stray light protection
    2) Have fold down doors on the East/West walls and leave up for wind/stray light protection
    3) Add a wind fence that can be raised or lowered if wind speed reduction is required.

- The key in the design is the location and height of the pier+ Polar align telescope height in relation to the observatory walls, the height of the walls to be able to do a polar alignment and to a see your desired minimum elevation.

Next steps to go to remote astrophotography (continued)

Roll-off roof observatory(continued)

- Here is a picture/equations of the design calculations to define pier location and wall heights to perform a polar alignment at your latitude. This can also be applied to the East and west wall height to obtained desired wind/stray light and/or minimum horizon viewing angles.



$L = R_h / \tan(\text{lat})$
$R_h / L = (P_h + M_h)/(L - P_x)$
$R_h * (L - P_x) = L*(P_h + M_h)$
$L - P_x = L*(P_h + M_h)/ R_h$
$P_x = L - L*(P_h + M_h)/ R_h$
$P_x = L *(1 - (P_h + M_h)/ R_h)$
$P_x = R_h / \tan(\text{lat}) *(1 - (P_h + M_h)/ R_h)$
$P_x = (R_h - P_h - M_h)/\tan(\text{lat})$

Note: (1) Telescope cartoon assumes a German equatorial mount, (2) Polar Alignment scope in mount

Telescope Observatory Design Sheet

Input values

Latitude (deg)	33
Roof height (ft)	8.75
Min Roof height (ft)	7.5
E/W wall height (ft)	7
Pier to Mount RA CL (ft)	1.125
Mount RA CL to dovetail (ft)	1
Telescope dia @ bulkhead (ft)	1.44
Telescope Mirror dia (ft)	1
distance from OTA front to DEC pivot (ft)	2.5
Telescope front bulkhead dia (ft)	1.1
Number of E/W piers	2
Number of E/W pier rows	1
Scope keep out radius around pier CL (ft)	3.5

- The upper left table shown below, defines the Pier CL distance from the north wall to achieve the desired North elevation angle as a function of Pier height for the shown input values.
  - The max scope height while in park (0 elevation north or south) and the max scope height are shown in the right columns
  - Red text/cell denotes the scope will not fit under the roof for the shown input values (in this example scope fits under roof for the park position, but not while in highest position.
- The lower left table shown below, defines the Pier CL distance from the East/West wall to achieve the desired viewing elevation angle as a function of Pier height for the shown input values.
  - The right most columns define the minimum south wall height to see to the horizon and the south door height (E/W wall height minus the south wall height)
- The upper/lower right tables shown below, define the minimum dimensions of the observatory for the selected input values, Pier Height and elevation viewing angles.

		North Elevation (deg)					Max Scope height @ N or S park (ft)	Max Scope height (ft)
		33	30	25	20	15		
		Pier CL distance from north wall (ft)						
Pier Height (ft)	0	11.7	13.2	16.4	20.9	28.5	1.85	4.38
	1	10.2	11.5	14.2	18.2	24.7	2.85	5.38
	2	8.7	9.7	12.1	15.5	21.0	3.85	6.38
	3	7.1	8.0	9.9	12.7	17.3	4.85	7.38
	4	5.6	6.3	7.8	10.0	13.5	5.85	8.38
	5	4.0	4.5	5.6	7.2	9.8	6.85	9.38
	5.1	3.9	4.4	5.4	6.9	9.4	6.95	9.48
	6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	6.5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

		North Elevation (deg)				
		33	30	25	20	15
		N/S observatory length (ft)				
Pier Height (ft)	0	15.2	16.7	19.9	24.4	32.0
	1	13.7	15.0	17.7	21.7	28.2
	2	12.2	13.2	15.6	19.0	24.5
	3	10.6	11.5	13.4	16.2	20.8
	4	9.1	9.8	11.3	13.5	17.0
	5	7.5	8.0	9.1	10.7	13.3
	5.1	7.4	7.9	8.9	10.4	12.9
	6	#N/A	#N/A	#N/A	#N/A	#N/A
	6.5	#N/A	#N/A	#N/A	#N/A	#N/A

		East/West Elevation (deg)						South Wall Height (ft) for 0deg elv	South Door Height (ft) for 0deg elv
		30	25	20	15	10	5		
		Pier CL distance from E/W wall (ft)							
Pier Height (ft)	0	8.9	11.0	14.0	19.1	29.0	58.4	0.63	6.88
	1	7.1	8.8	11.3	15.3	23.3	47.0	1.63	5.88
	2	5.4	6.7	8.5	11.6	17.6	35.6	2.63	4.88
	3	3.7	4.5	5.8	7.9	12.0	24.1	3.63	3.88
	4	1.9	2.4	3.1	4.1	6.3	12.7	4.63	2.88
	5	0.2	0.2	0.3	0.4	0.6	1.3	5.63	1.88
	5.1	0.0	0.0	0.0	0.0	0.1	0.1	5.73	1.78
	6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	6.5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

		East/West Elevation (deg)					
		30	25	20	15	10	5
		E/S Observatory Width (ft)					
Pier Height (ft)	0	24.7	28.9	35.1	45.1	65.0	123.8
	1	21.2	24.6	29.6	37.7	53.6	101.0
	2	17.8	20.3	24.1	30.2	42.3	78.1
	3	14.3	16.1	18.6	22.8	30.9	55.2
	4	14.0	14.0	14.0	15.3	19.6	32.4
	5	14.0	14.0	14.0	14.0	14.0	14.0
	5.1	14.0	14.0	14.0	14.0	14.0	14.0
	6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	6.5	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

Next steps to go to remote astrophotography (continued)

Roll-off roof observatory (continued)

4) **whether a warming room is to be attached**.

- Although a warming room is great and makes observing more enjoyable, it does create some design issues for the roof and possibility some operational issues.
- To reduce observatory footprint with a roll-off roof, the roof needs to roll over the warming room.
  - This will usually make the observatory roof portion higher than without a warming room. This may results in a higher pier and can cause a raised sub floor to be added to allow easier telescope maintenance or modifications.
  - However, to minimize the roof height, the roll-off roof is generally only inches above the warming room roof .
  - For roof structural stiffness the end of the roof farthest from the warming room need horizontal stiffeners that extend down from the peak of the roof 1-2 feet. When the roof is fully opened these horizontal stiffeners are up against the warming room wall.
  - The peak of the roof is now the highest point of the roof. If the roof opens to the North, the telescope must look over the roof peak to see Polaris as was discussed in the design section.
  - The problem is worse, if you want to raise the roof to provide roof clearance above the scope during opening and closing.

Next steps to go to remote astrophotography (continued)

Roll-off roof observatory (continued)

4) **whether a warming room is to be attached. (continued)**

- As the roof is raised above that of the warming room and to be able to see Polaris there are only several options; 1) make the observatory larger to allow the piers to be further from the north wall to see Polaris, 2) move the roof further to the North, or 3) Move the roof to the south.
  - Option 1) This option adds cost as the footprint of the observatory/roof must be increased.
  - Option 2) To move the roof further to the North requires the roof to be raised for the roof stiffeners to clear the warming room North wall.
    - This will increase the cost, but it also provides additional headroom for the roof to clear the scope at it highest position during opening and closing.
    - Another disadvantage is that the roof needs to be moved farther than it length, which increases the complexity of the roof opening mechanism.
      - However if the observatory roof length is shorter than the warming roof length, this would provide additional real-estate to move the roof further to the North.

Next steps to go to remote astrophotography (continued)

Roll-off roof observatory (continued)

4) **whether a warming room is to be attached. (continued)**

- Option 3) Moving the roof to the South allows the piers to be closest to the North wall and the smallest observatory footprint to be able to do a polar align.
  - However, the warming room with the observatory roof opened just increased the total foot print by about 50%.
  - Major disadvantage is the loss of the southern horizon. The polar align issue has been mitigated, but we just moved the problem to the south side by raising the South seeing horizon.
    - This can be improved slightly by moving the roof further to the South, but would still have issue of adding complexity to the opening and closing mechanism by having to open the roof further than its length.
  - To counter the major disadvantage with this option, the warming room and observatory could be rotated so that it was in the east/west direction
    - Provides East/West wind/stray light protection
    - North wall height can be tailored to just provide Polaris seeing or also some wind/stray light protection

Next steps to go to remote astrophotography (continued)

Roll-off roof observatory (continued)

4) **whether a warming room is to be attached. (continued)**

- To counter the major disadvantage with this option, the warming room and observatory could be rotated so that it was in the east/west direction (continued)
  - The South wall can also be tailored for wind/stray light protection or a better southern horizon. Southern wall can have a hinged or removable door to improve south horizon down to zero degrees.
- Note that all the group observatory building I have seen, open/close the roof in the east/west direction.

Next steps to go to remote astrophotography (continued)

Roll-off roof observatory (continued)

Roof open/close mechanisms

- Lots of choices…..person power, chains, cable, rack or wheel driven motor.
- Ideally, the roof should be open/closed by pulling or pushing on the center of the roof.
  - This keeps the roof wheel loads on the left and right side symmetric to prevent the roof from twisting during opening or closing. Although the issue of roof twisting should only be a issue with very large roofs.
    - For normal size observatories and assuming the roof is stiff, opening the roof from only one side should present no problem.
    - I have a 15x21 foot steel roof and open the roof by pulling only on one side and I have never had an issue. Although, after the observatory expansion upon opening the roof I can see the effects of the resulting torque trying to twist the roof
- Although from a maintenance point of view the center roof pull may be a disadvantage especially if the roof moves over the warming room. Better to pull from the side to have better access, especially if only behind a removable panel versus between the observatory and warming room roofs.

Using input values from the Telescope Observatory Design Sheet the following was obtained.

Pier Height (ft)	Observatory North/South Length (ft)	Observatory East/West Length (ft)	Observatory South Wall Height (ft)	North Horizon Elevation (deg)	E/W Horizon Elevation (deg)	South Horizon with door Elevation (deg)	Scope fits under roof @ horizontal park	Scope fits under roof during slew
5.15	7.8	14	5.78	30	0	0	Yes	No
	8.8	14	5.78	25	0	0	Yes	No
	10	14	5.78	20.8	0	0	Yes	No
4.5	8.9	14	5.13	30	9.9	0	Yes	No
	10	14	5.13	25.8	9.9	0	Yes	No
	10	15	5.13	25.8	8.7	0	Yes	No
3.9	10	14	4.93	30	20	0	Yes	No
	10	15	4.93	30	16.8	0	Yes	No

East/West Walls @ 4feet

Pier Height (ft)	Observatory North/South Length (ft)	Observatory East/West Length (ft)	Observatory South Wall Height (ft)	North Horizon Elevation (deg)	East/West Horizon Elevation (deg)	South Horizon with door elevation (deg)	Scope fits under roof @ horizontal park	Scope fits under roof during slew
3	11.5	14	3.63	30	0	0	Yes	Yes
	13.4	14	3.63	25	0	0	Yes	Yes
	15.7	14	3.63	20	0	0	Yes	Yes
	20.8	14	3.63	15	0	0	Yes	Yes

East/West Walls @ 7feet

Pier Height (ft)	Observatory North/South Length (ft)	Observatory East/West Length (ft)	Observatory South Wall Height (ft)	North Horizon Elevation (deg)	East/West Horizon Elevation (deg)	South Horizon with door elevation (deg)	Scope fits under roof @ horizontal park	Scope fits under roof during slew
5.15	12.2	14	3.63	30	0	0	Yes	Yes
	14.2	14	3.63	25	0	0	Yes	Yes
	16.7	14	3.63	20	0	0	Yes	Yes
	22.2	14	3.63	15	0	0	Yes	Yes

Roof Height 11.28’ for scope slew clearance with Roof

Next steps to go to remote astrophotography (continued)
Observatory Design Summary

- Best overall observatory for a single pier is a rotating dome
  - Provides best stray light and wind protection and allows 0 degrees horizon viewing over the entire 360 degrees of azimuth
  - Scope can be slewed with dome closed and during dome opening/closing with no possibility of scope/dome contact
  - Disadvantage can be cost and if warming room is to added, a higher pier that may require ladder or raised sub floor to facilitate telescope maintenance or equipment change.
  - Telescope slew and dome need to be coordinated during operation
- Best overall observatory for multiple piers is a roll-off roof
  - Can be DIY and can be lower cost
  - Does require a compromise on horizon and stray light/wind protection.
    - Can provide stray light/wind protection in all directions with option of 0 deg south horizon

    OR

    - Can provide 0 degree horizon in E, S, W directions with a little stray light/wind protection in N direction

Next steps to go to remote astrophotography (continued)

Observatory Design Summary

- Best overall observatory for multiple piers is a roll-off roof (continued)
  - If with warming room, Rolling the roof north over warming room provides smallest observatory footprint and best overall set of operational options
    - E/W/S stray light/wind protection or with a south door that opens allowing a 0 deg south horizon or 0 deg E/W/S horizon with only N stray/light/wind protection
    - If roof is to be raised to allow scope slewing while roof closed, observatory N/S length must be increased, the roof must move further North than South side of warming room, or some combination of both to allow polar alignment.

Operating in an Remote Observatory

- A remote observatory with limited or no supervision is quite different from a supervised observatory where the user or tech is overseeing the minute to minute telescope operation.
- A lot of astroimagers slowly move away from supervised telescope operation, starting with using automated imaging scripts to allow the user to reduce the workload or to get some sleep versus staying up all night.
- However, as we move to more automation without some means of fault detection and recovery, there is additional risk in something bad happening. But at the same time, every time we add fault detection and recovery we are adding more complexity and creating more things that could go wrong.
- And this is just magnified as we move into a remote observatory.
- So we have to do an educated balancing act of risk versus safety versus a long duration road trip. Everyone will have a different opinion on this, but here are my decisions and rationale. Only time will tell if my decisions were well founded or not.

Operating in an Remote Observatory

I choose Deep Sky West as my remote telescope hosting.

- Lower Price than SRO and New Mexico skies and in a cost analysis comparing building an observatory versus leasing pier space the cost per hour results seems to be similar. Actually leasing cost/hour was better than building an observatory. Price break even was over 10 years.
- SRO had no availability and had to wait on new building which supposedly started Oct 2018. All building are raised floors with many steps, I would not be able to get in. Price was not reasonable! Kevin Moore's price was over 1/3 less than new building leasing cost.
- DSW was building new building with finish date of fall of 2018. As of December 31, 2018 not completed.
- With DSW could buy piers and stands for light panel. Didn't have room in car to take pier.
- DSW at 7200 feet elevation

Update: learned about Sky Pi recently, which is similar to DSW, if I had known about all the DSW delays, I may have gone with Sky Pi and been using the remote setup for several months by this time. Biggest downside is Internet bandwidth as using satellite internet.

Deep Sky West (DSW)

deepskywest.com

Deep Sky West

deepskywest.com

Deep Sky West

deepskywest.com

ROBUST INFRASTRUCTURE

- Remote Observatory Building: 25×60' corrugated Steel Master A-Model Quonset Hut
- The design of the observatory provides horizon to horizon coverage down to at least 25 degrees
- The observatory is actuated by an electric motor which rolls the entire structure to expose the telescopes to the sky
- An inner stem wall structure provides protection from ground-level wind
- The structure is engineered to withstand snow and wind loads associated with local conditions
- All equipment is insured. Each member hosting equipment is also required to carry insurance. Premiums vary but should be less than $300/year. We can refer you to an insurance broker to assess your insurance needs if you need help.
- Each of the 18 isolated imaging locations are on 7×7 foot squares with custom built, 0.25" thick-walled, cold-rolled steel piers available.
  The piers have a flat top surface with universal tapped holes to fit Software Bisque and A-P mounts. Other mount brands can be accommodated as well.

Deep Sky West

deepskywest.com

EXCELLENT LOCATION

- Excellent Location
- Rowe, New Mexico, 35.32N latitude, 105.72W longitude. Elevation 7,400 feet
- Albuquerque (pop. 555,000, ~ 54 miles WSW)
- Santa Fe (pop. 69,000, ~27 miles NW)
- SQM range: >= 21.7
- Seeing range: 1-2"; 0.8 observed

Four minutes to open or close roof

Deep Sky West

deepskywest.com

SOPHISTICATED INSTRUMENTATION & CONTROLS

- 100 Mbps fiber Internet connectivity (up and down)
- M1OASYS Observatory automation and control
- Interactive Astronomy's SkyAlert Cloud Sensor (primary rain sensing)
- Hydreon Optical Rain Sensor (secondary rain sensing)
- Hunter Rain-Clik (tertiary rain sensing)
- Interactive Astronomy's SkyEye All Sky Camera
- Unihedron Sky Quality Meter
- Bosch and Custom Low Lux Surveillance Cameras
- Clear Sky Chart
- Cisco Meraki Cloud Managed network infrastructure

Deep Sky West

deepskywest.com

Join an existing team.

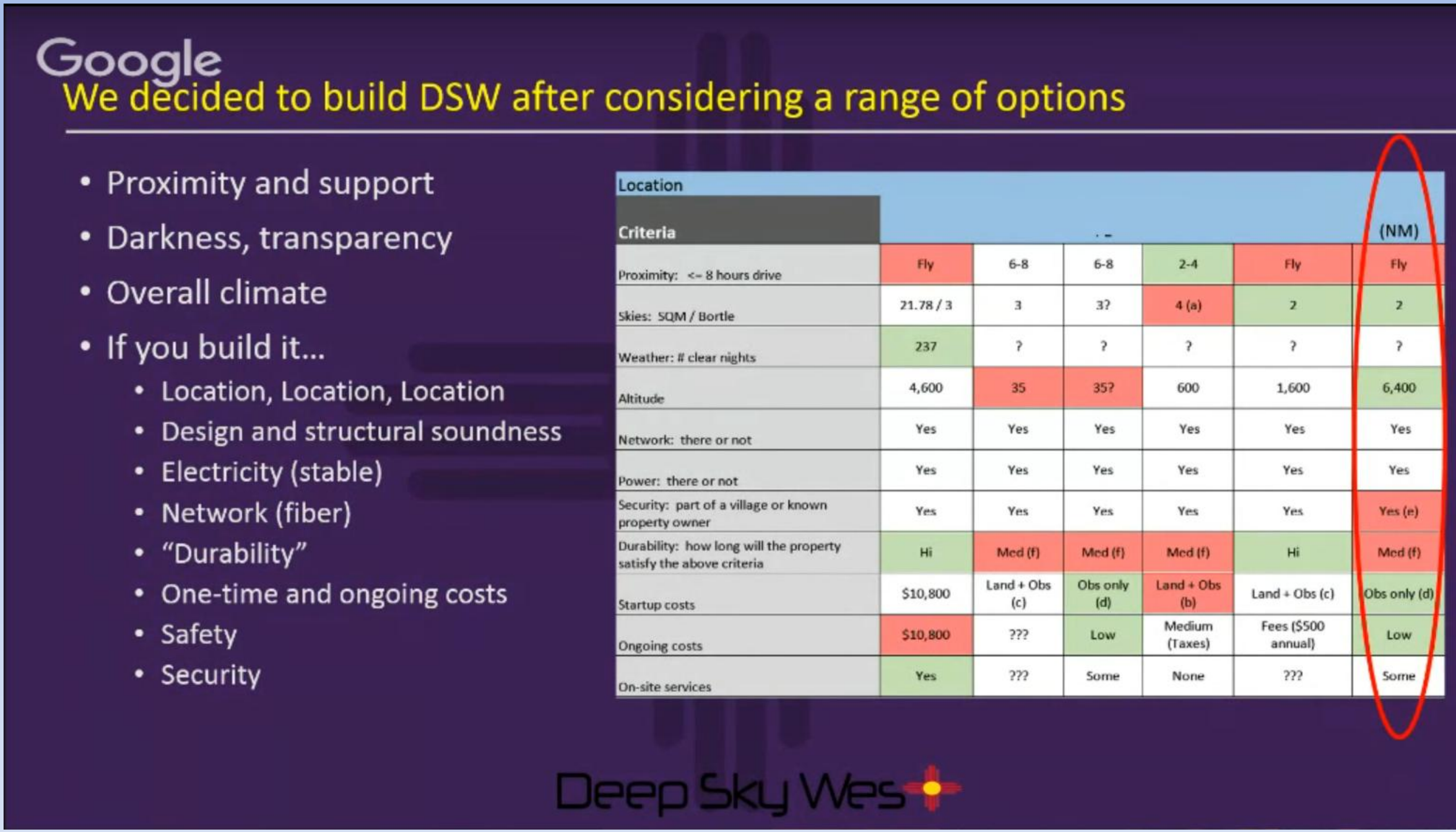
This is the easiest way to get involved and only requires you to find a team looking for members. DSW helps facilitate this process as needed. This website promotes team formation by allowing prospective members to post the equipment they'd be willing to install at DSW Interested members with complimentary equipment, or in some cases no equipment at all can post and apply to be a part of a team. We expect some teams to be 1 or 2 members, or in other cases the maximum of 7. Our experience tells us that between 3 and 7 is about right considering getting agreement on target selection, image integration requirements, image quality requirements, etc.

Join a DSW-Operated Teams (as low $600/year)

DSW staff operate 7 "in-house" systems based on a subscription model. All members get all data--as many as 50 complete data sets per year. There are 7 currently available options:

1. RC Optical 14.5" Carbon Truss + SBIG STX-16803 + Adaptive Optics + Paramount ME ($2,400 / year)
2. Astro-Physics RH-305 + FLI ML8300 +Paramount ME ($1,800 / year)
3. Officina Stellare RH200 + FLI ML16200 +Paramount MX ($1,200 / year)
4. Astro-Physics RH-305 + SBIG STX-16803 +A-P 1600 ($2,000 / year)
5. Rokinon 135mm f/2.8 "Ultra Wide Field" + QSI583ws +Paramount ME ($600 / year)
6. FSQ-106 + MyT + QSI683wsg-8 ($1,200 / year)
7. Astro-Physics 175 Starfire Refractor + FLI PL16070 + A-P 1600AE ($2,400 / year)

DSW History

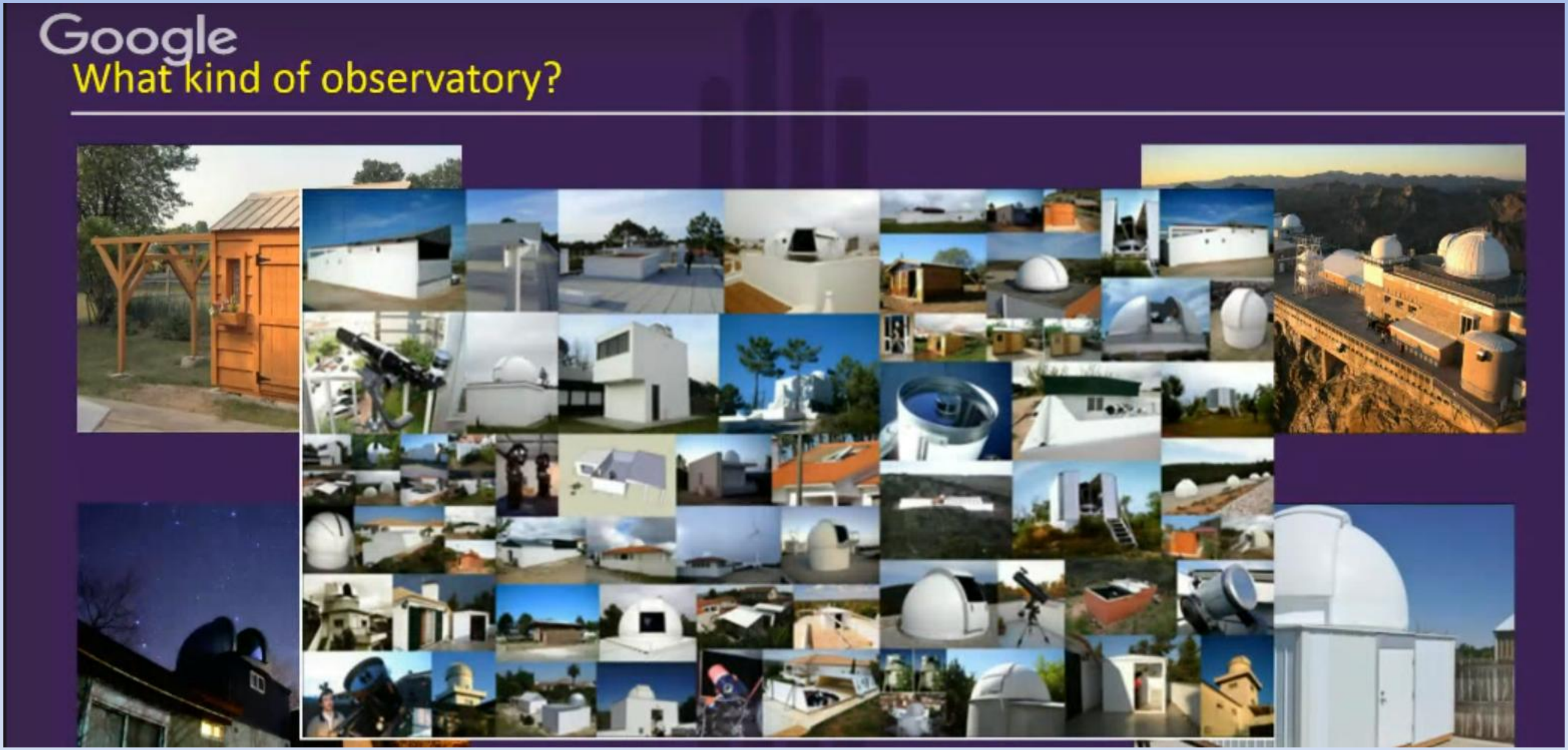


Location						
Criteria						(NM)
Proximity: <~ 8 hours drive	Fly	6-8	6-8	2-4	Fly	Fly
Skies: SQM / Bortle	21.78 / 3	3	3?	4 (a)	2	2
Weather: # clear nights	237	?	?	?	?	?
Altitude	4,600	35	35?	600	1,600	6,400
Network: there or not	Yes	Yes	Yes	Yes	Yes	Yes
Power: there or not	Yes	Yes	Yes	Yes	Yes	Yes
Security: part of a village or known property owner	Yes	Yes	Yes	Yes	Yes	Yes (e)
Durability: how long will the property satisfy the above criteria	Hi	Med (f)	Med (f)	Med (f)	Hi	Med (f)
Startup costs	$10,800	Land + Obs (c)	Obs only (d)	Land + Obs (b)	Land + Obs (c)	Obs only (d)
Ongoing costs	$10,800	???	Low	Medium (Taxes)	Fees ($500 annual)	Low
On-site services	Yes	???	Some	None	???	Some

DSW charts obtained from presentation given to the "The Astro Imaging channel" on October 4, 2015.

https://youtu.be/j1Z-V3h6UM4

DSW History (continued)



DSW History (continued)

Observatories down in Chile

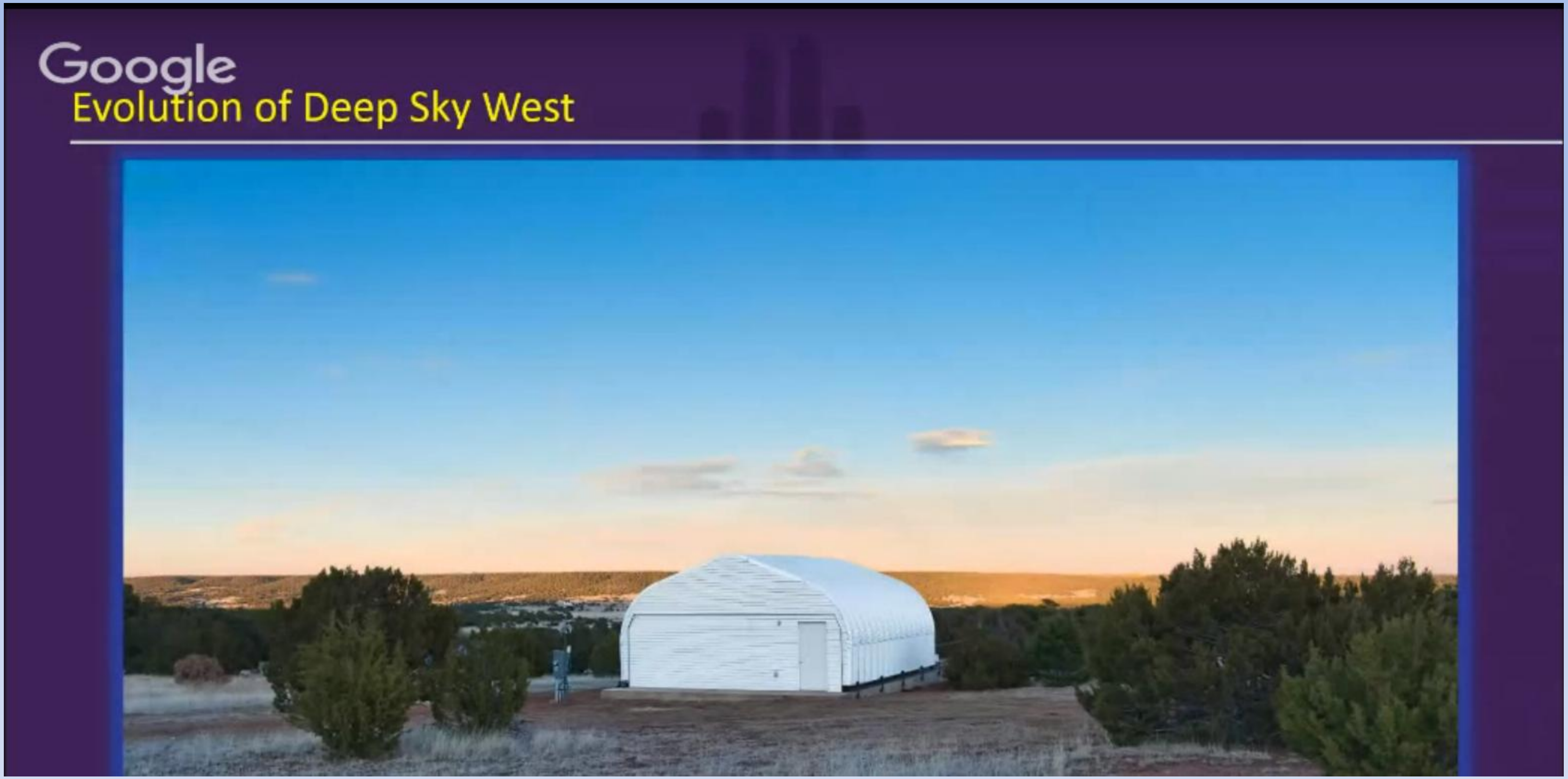
DSW History (continued)

What do you need to go remote?

- ✓ Location, Location, Location
  - Astrometric nights
  - Infrastructure
  - Security
  - Support
  - Structure
- Local Contractors
- Software
  - Control: CCDAP, ACP, SGP
  - Planetarium: The SkyX (CAO)
  - Plate Solving: TSX, Pinpoint
  - Focusing: FocusMax, CAO
- Hardware
  - Mount
  - OTA
  - Focuser
  - Rotator
  - Power Management
  - Network
  - Cloud Sensors
  - Rain sensors
  - IP Cams
  - Computers

DSW History (continued)

DSW History (continued)



1st Phase was Observatory with 9 piers
2nd phase was Observatory alpha expanded to 18 piers
3rd phase was adding Observatory beta with 18-22 piers
Roof being added as of 9/27/2018
Roof complete and weather tight as of 12/19/2018

DSW History (continued)

Google

DSW: Current Status

- August 3, 2015 go-live date
- Space available for starters and joiners
- We have an A-P 1100GTO available for a team starter…FCFS (*contact Lloyd off-line*)

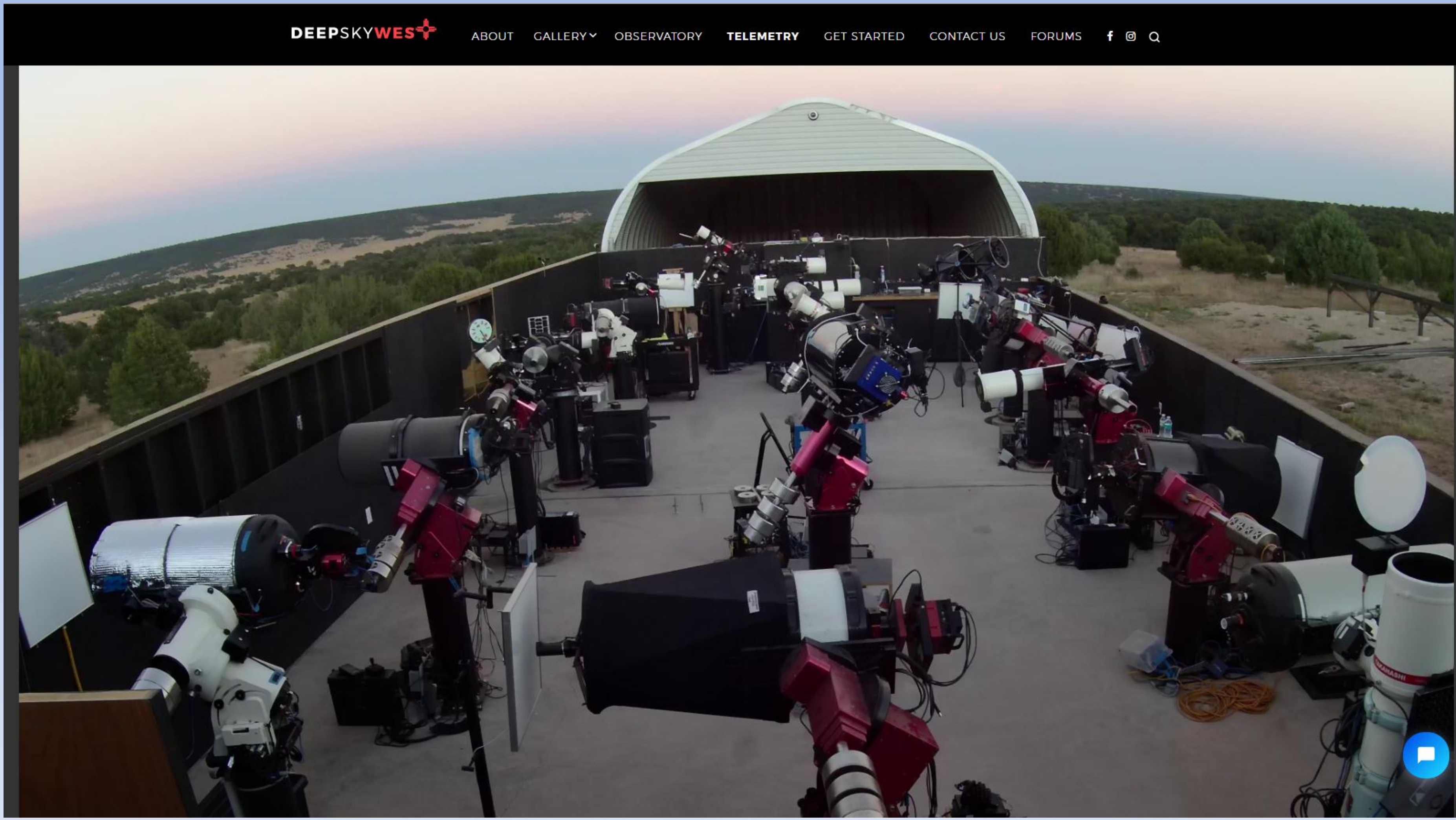
Contact Information

Lloyd Smith
678.427.6341
Sixburg@Me.com

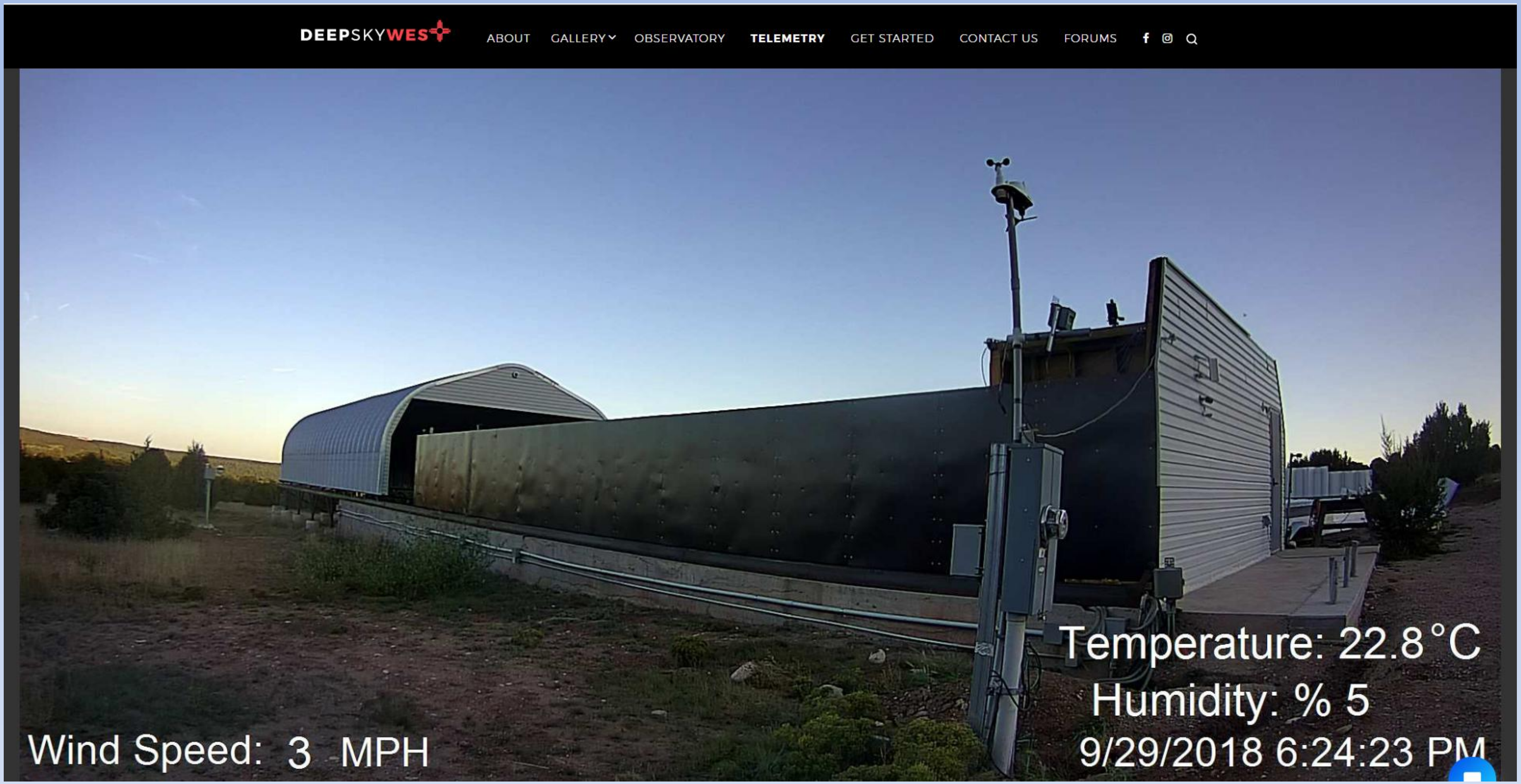
Bruce Wright
704-904-2776
rbwright77@mac.com

DeepSkyWest@DeepSkyWest.com

Additional information on Promotional video - https://youtu.be/JKYWnztlGO8

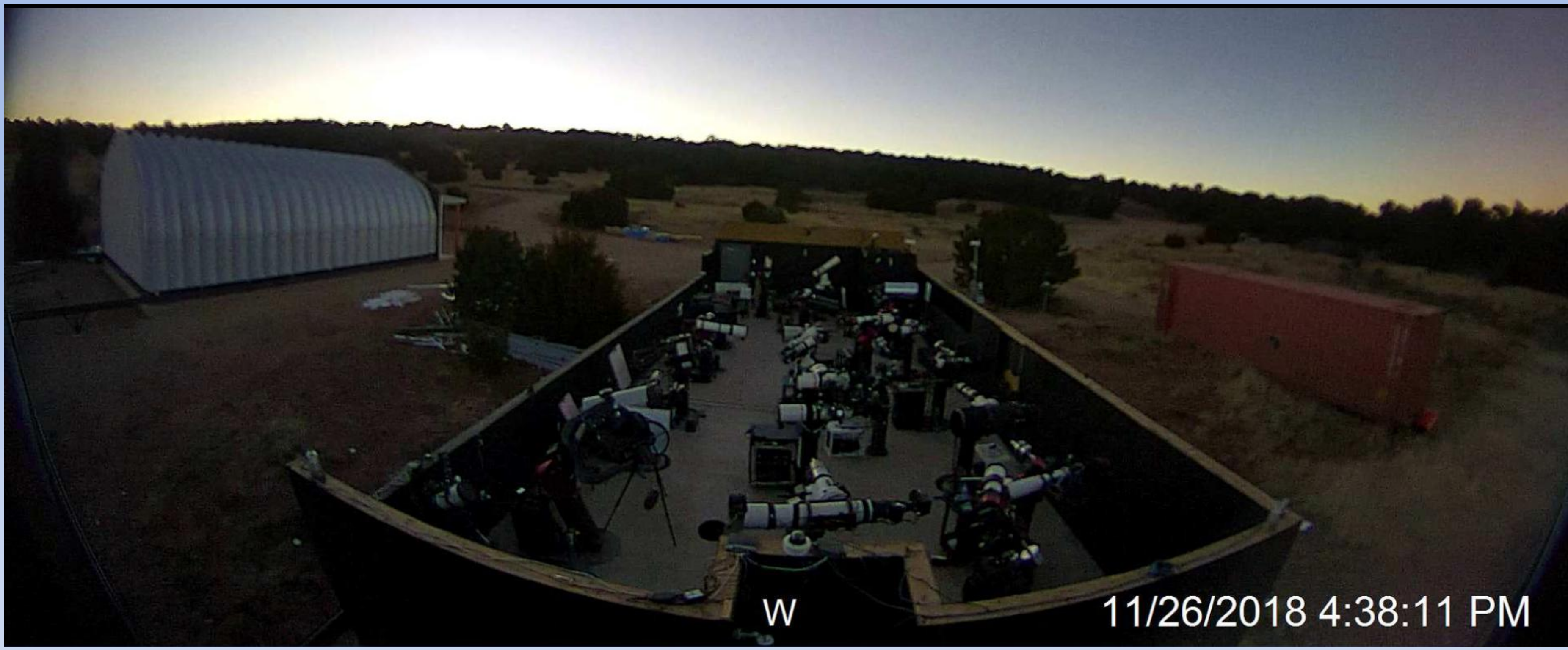


DSW on-site camera shots

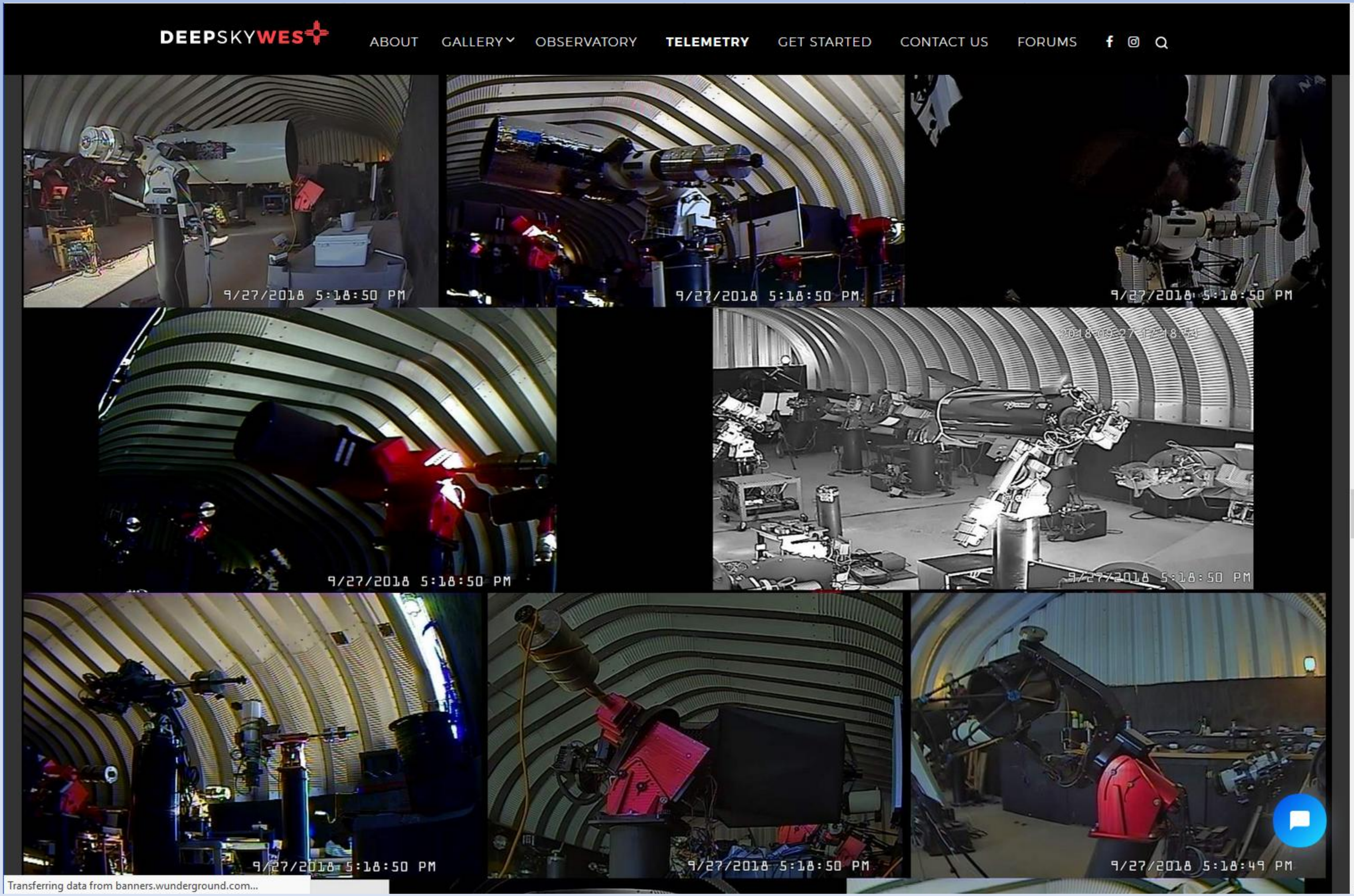


DSW on-site camera shots

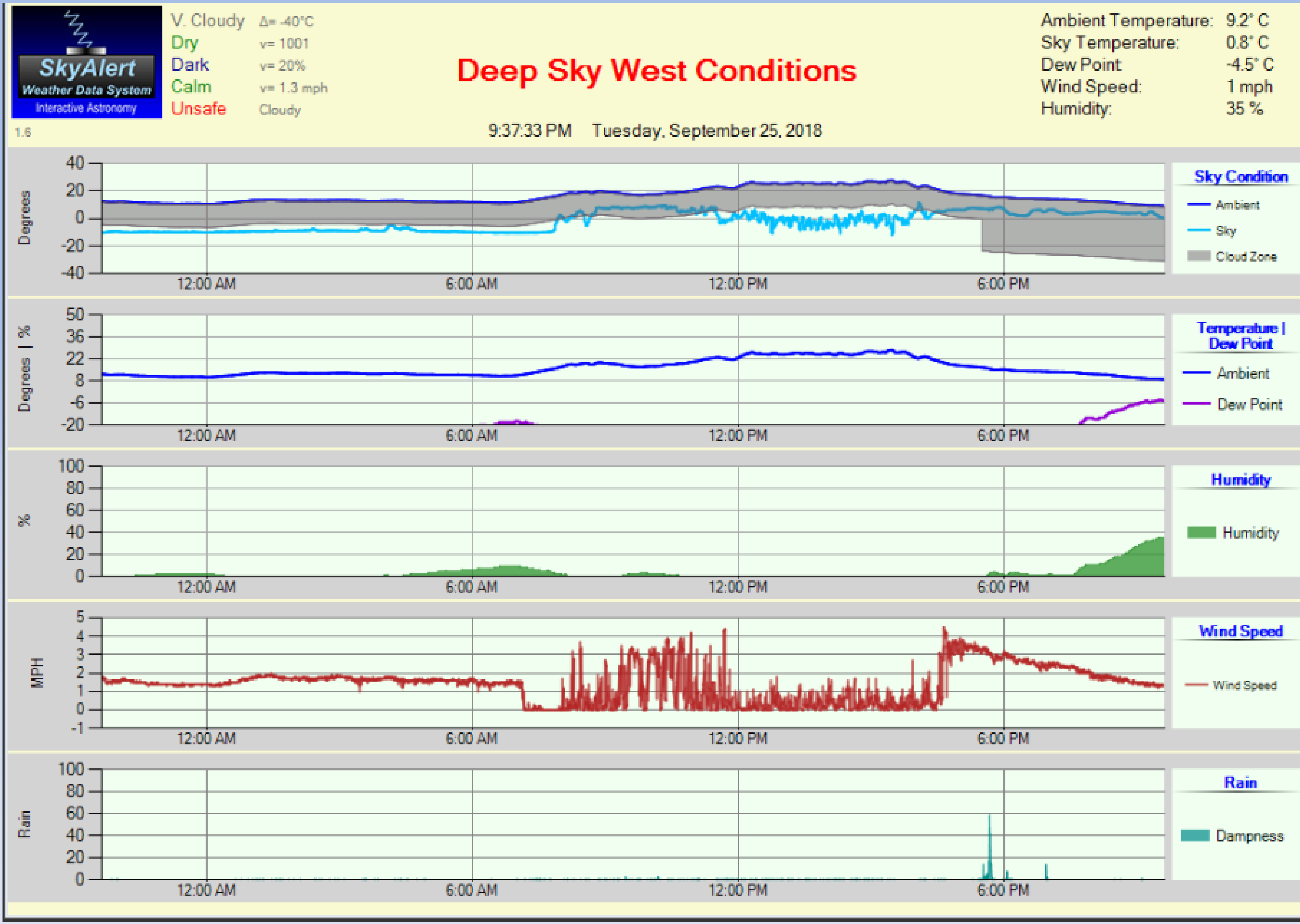
DSW Alpha and Beta



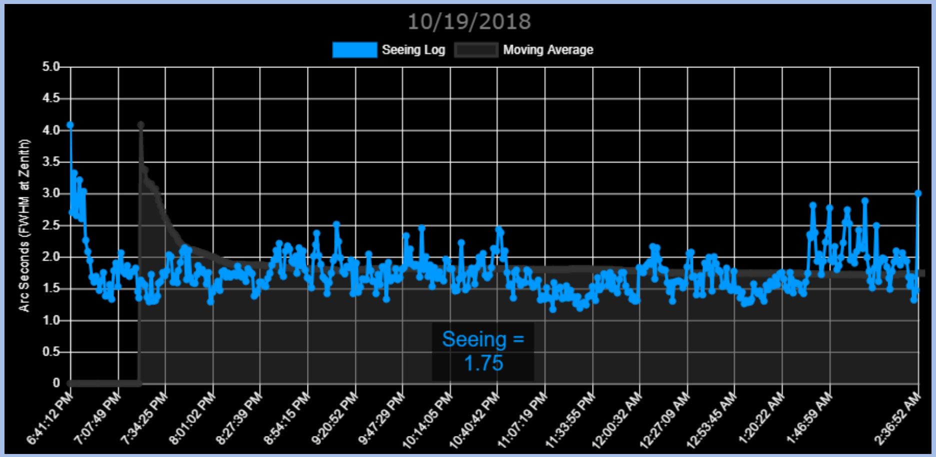
DSW on-site camera shots

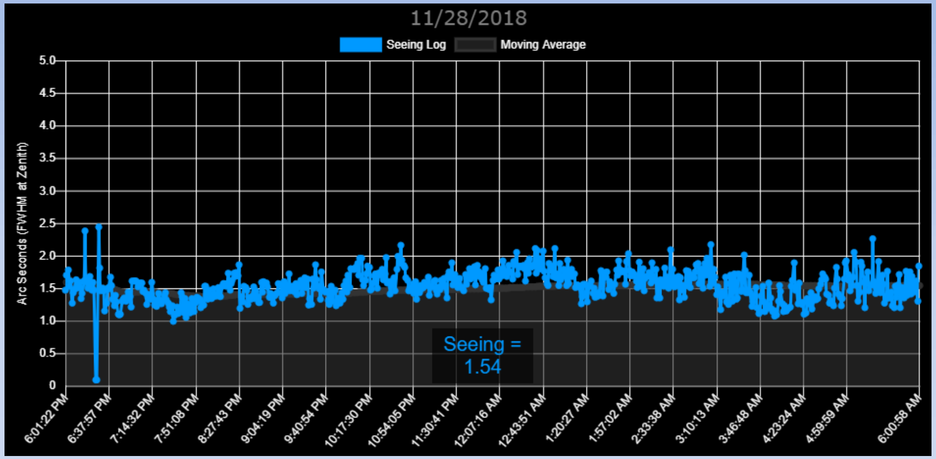


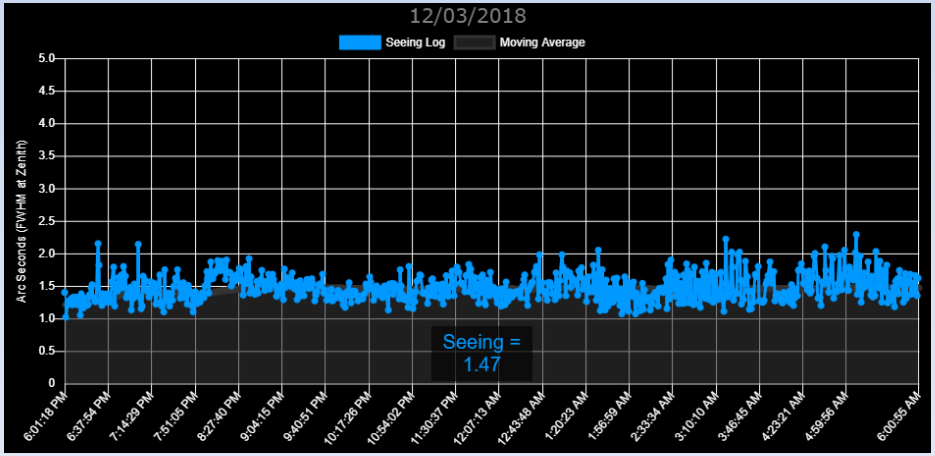
DSW on-site under roof camera shots



DSW On-site Weather



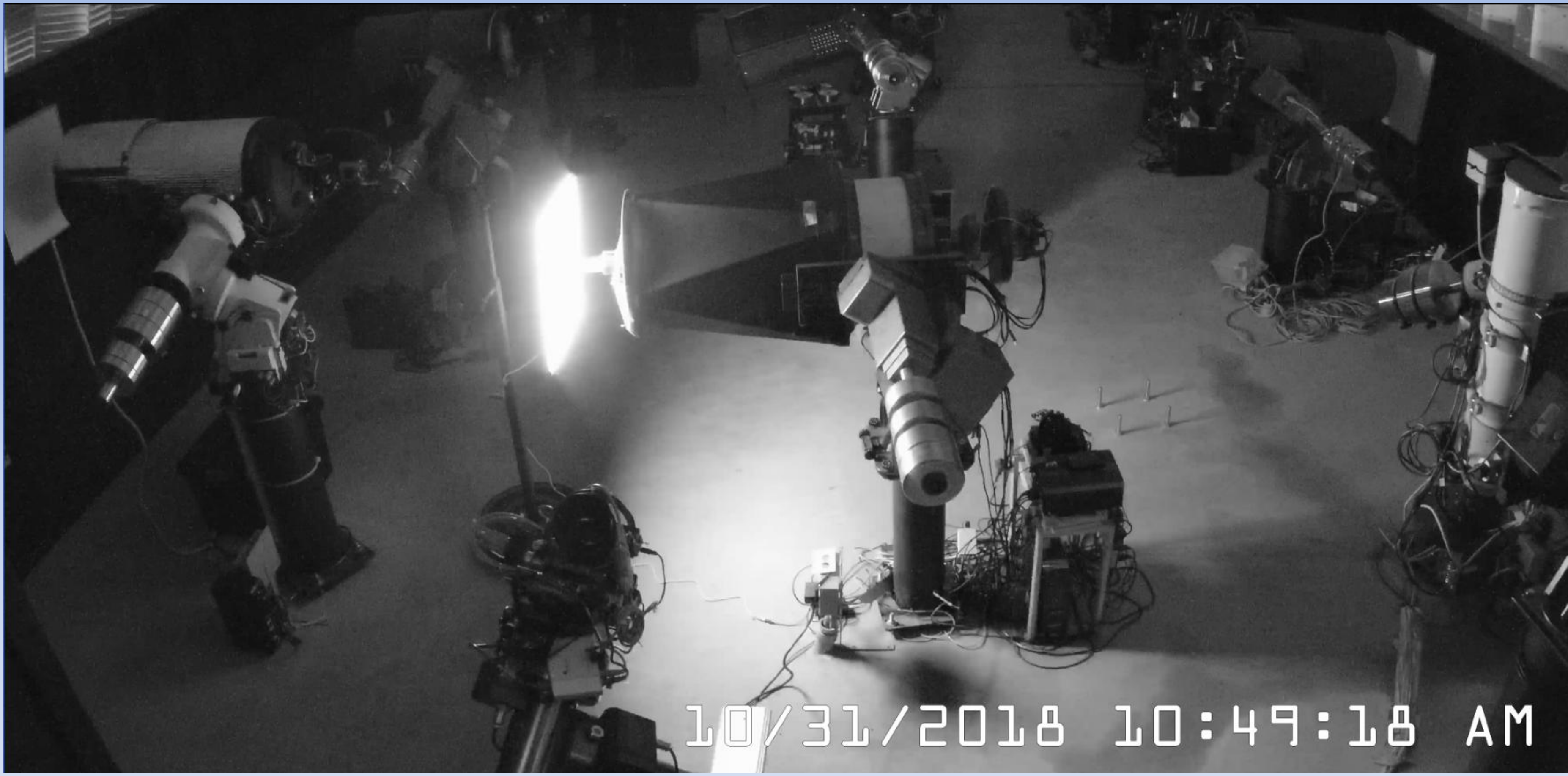




Best all night Seeing at DSW

DSW Beta Build Timelapse

Disadvantage of have a telescope in a group Observatory



Another person shooting flats at the wrong time

Disadvantage of have a telescope in a group Observatory

Group observatory pictures on a new moon night after twilight end

Things that can go wrong

Fallen Light Panel preventing the shooting of flats that requires a trip or someone to put up and align panel

DSW roof Opening/Closing protocol

1) Wind gust up to 15mph
2) Humidity > 85%
3) Power Failure
4) WAN failure
5) Very cloudy" (the difference between infrared measured sky temperature and ambient temperature <= between -17 and -20C)
6) Rain

This is not a complete list

2018 DSW Observing Statistics

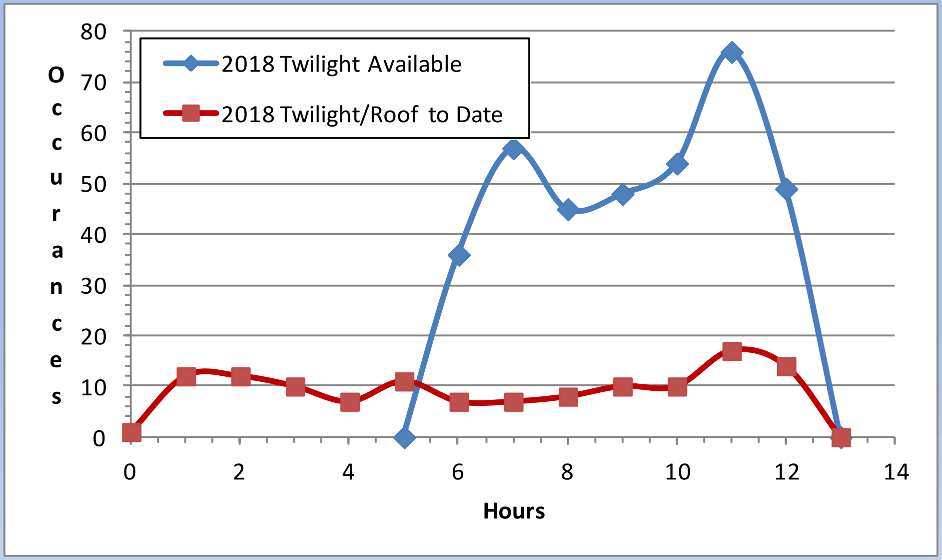
Month (2018)	Twilight delta (hr)	Twilight No Moon delta (hr)	Roof/Twilight delta (hr)	Roof/Twilight No Moon delta (hr)	Roof Open Twilight/No Moon (%)	Days Open (days)	Predicted Days Open (days)	Seeing (arc-sec) Average	Seeing Standard Deviation	Seeing 99% [1] Standard Error
Jan	339.2	170.9	0.0	0.0	0	0	20.8			
Feb	285.9	157.1	0.0	0.0	0	0	17.9			
Mar	283.5	138.4	0.0	0.0	0	0	20			
Apr	235.4	117.2	0.0	0.0	0	0	19.5			
May	203.5	97.3	0.0	0.0	0	0	19.2			
Jun	175.9	84.5	0.0	0.0	0	0	17.6			
Jul	193.9	88.1	33.2	10.2	11.5%	7	13.3			
Aug	230.8	104.3	86.6	31.3	30.0%	15	13.3			
Sep	262.6	123.2	168.5	79.7	64.7%	23	15.8	2.15	0.39	0.30
Oct	307.2	149.6	118.6	42.9	28.7%	15	21.4	1.75	0.28	0.24
Nov	323.4	164.8	215.6	105.9	64.3%	26	21.2	2.06	0.47	0.27
Dec	346.5	176.3	158.8	85.9	48.7%	20	19.1	1.99	0.53	0.39
Total	3187.8	1571.7	781.3	355.8	--------	106.0	219.1	--------	--------	--------
					Predicted Days open	104.1				

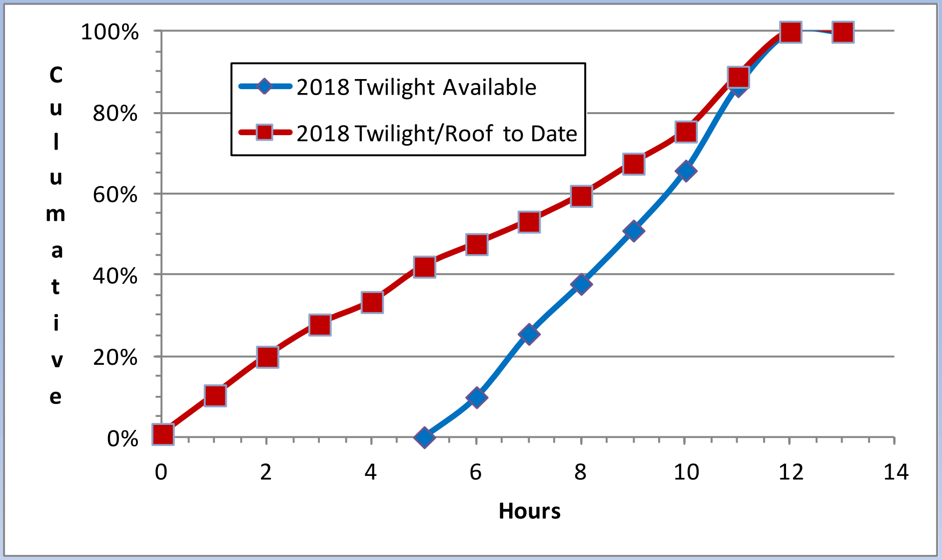
Days Elapsed	183.0
Days Roof Open	106.0
Days Roof Open percentage	57.9%
Annual Projected Roof open days	211.4
Total Roof open hrs wrt Twilight	781.3
Annual Projected open hrs wrt Twilight	1558.0
Hours Roof Open wrt Twilight percentage	48.9%
Roof Open wrt Twilight hrs per day open Ave	7.4
Twilight hrs/day Available Ave	8.7
ave cost per hr wrt Twilight	$5.39
Total Roof open hrs wrt Twilight/No Moon	355.8
Annual Projected open hrs wrt Twilight/No Moon	709.6
Hours Roof Open wrt Twilight/No Moon percentage	45.2%
Roof Open wrt Twilight/No Moon hrs/Days open Ave	3.4
Twilight/No Moon hrs/day Available Ave	4.3
ave cost per hr wrt Twilight/No Moon	$11.84

Data only available July through December 2018

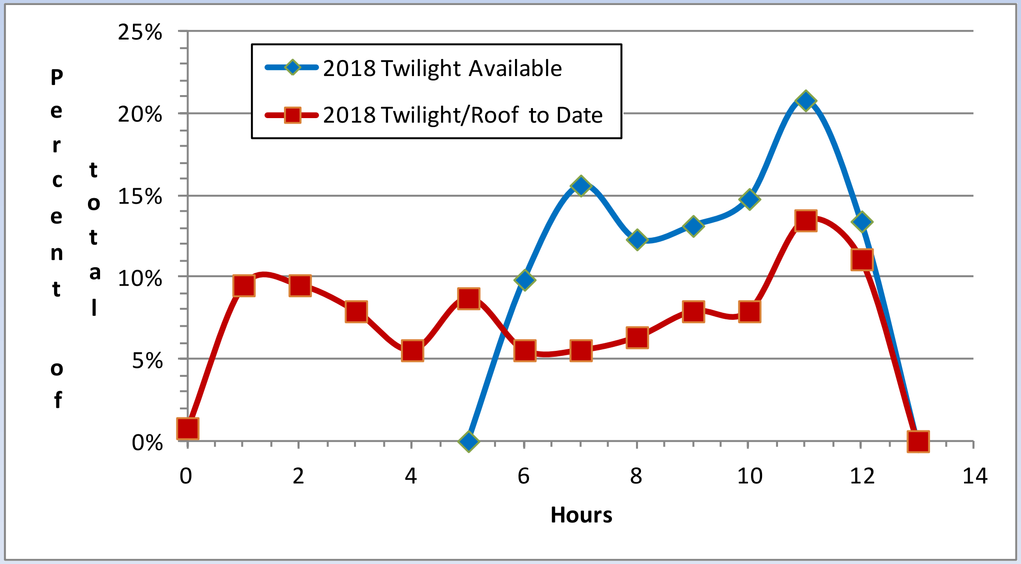
DSW Roof Open Statistics (continued)

Twilight End to Twilight Begin



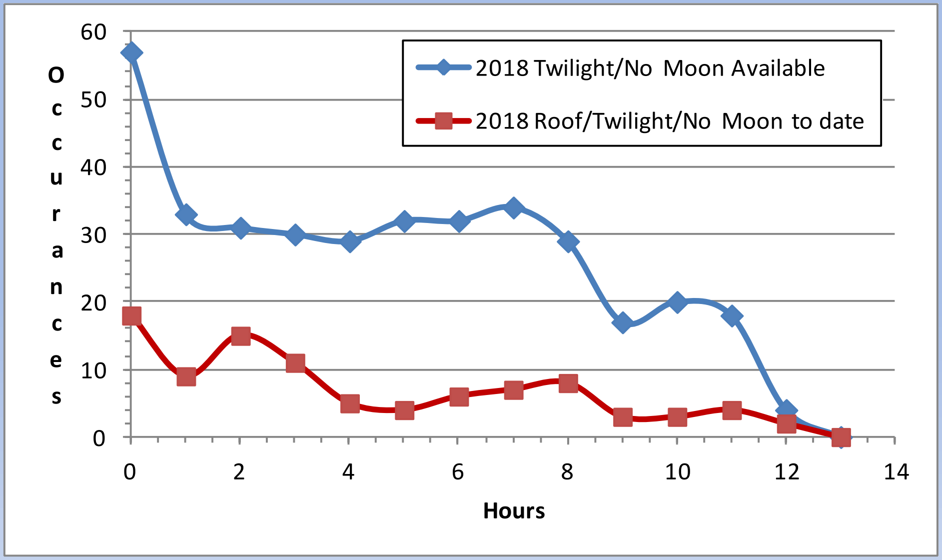


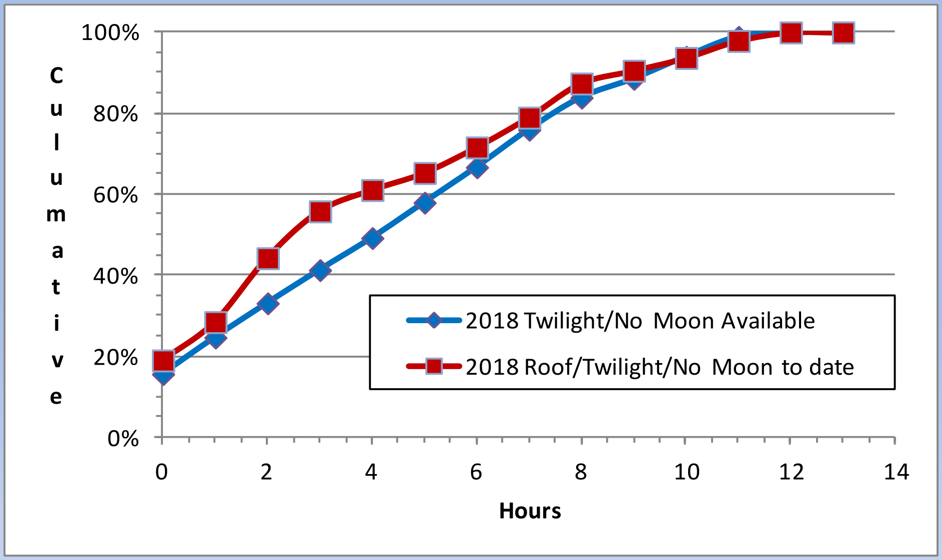
To Date – July to December



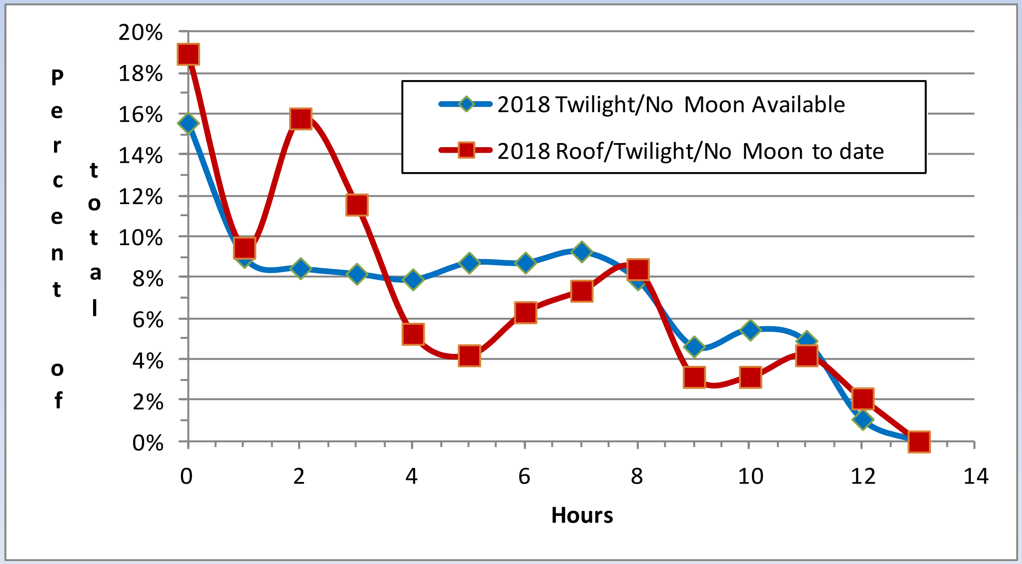
DSW Roof Open Statistics (continued)

Twilight End to Twilight Begin/No Moon





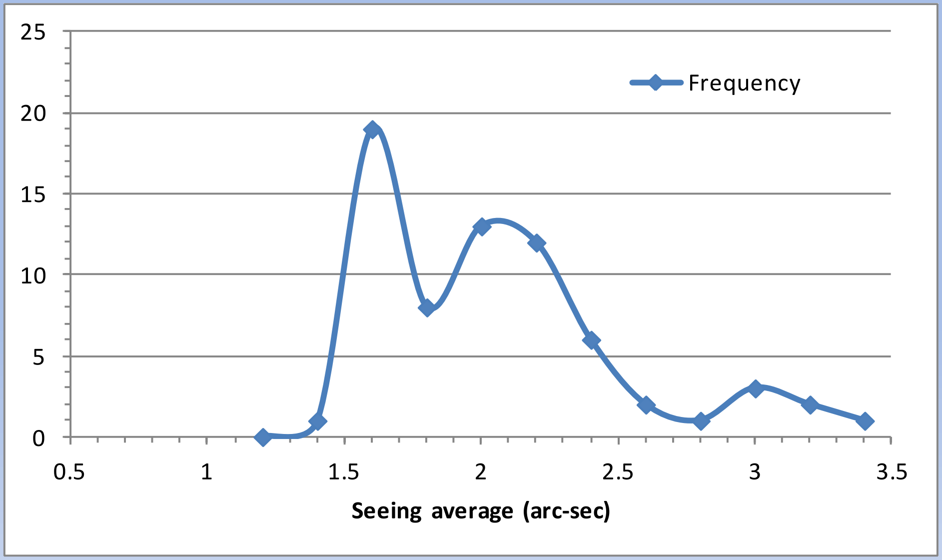
To Date – July to December

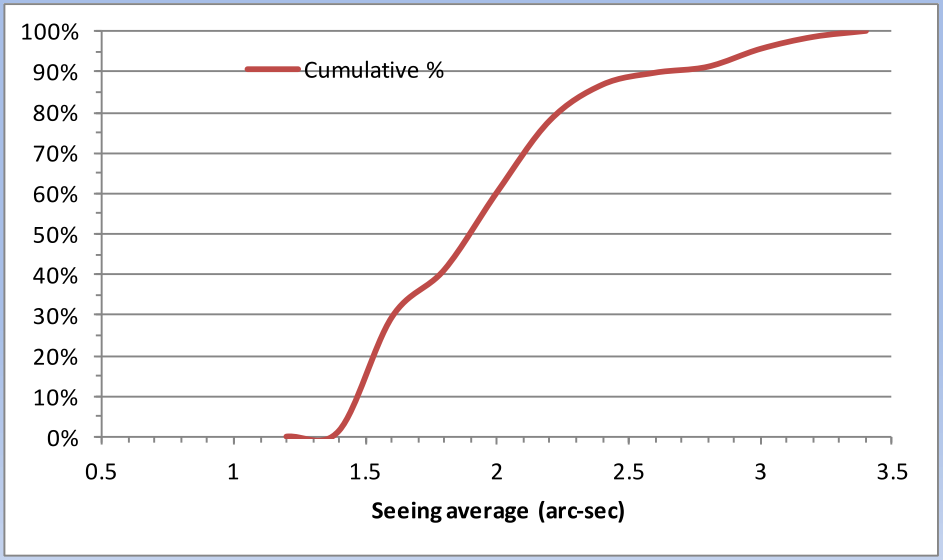


DSW Seeing Statistics (continued)

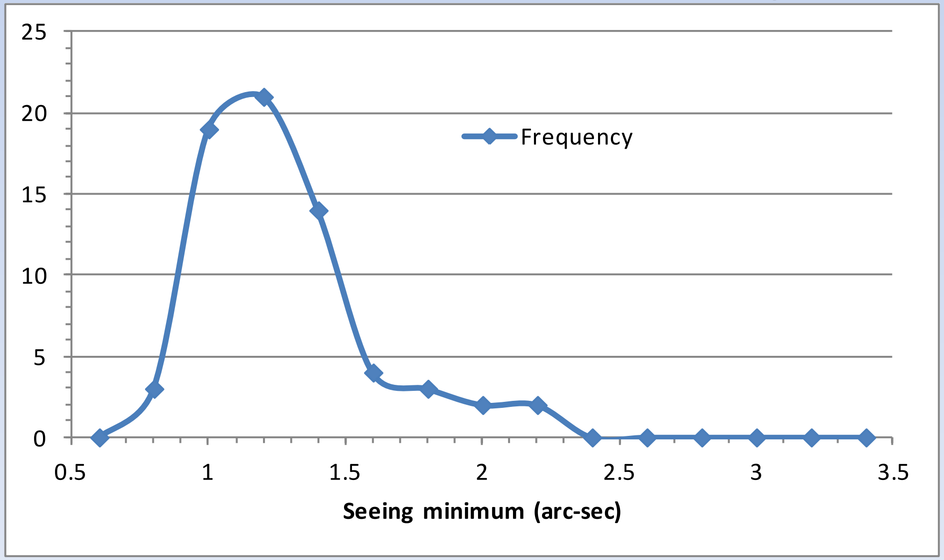
September to December

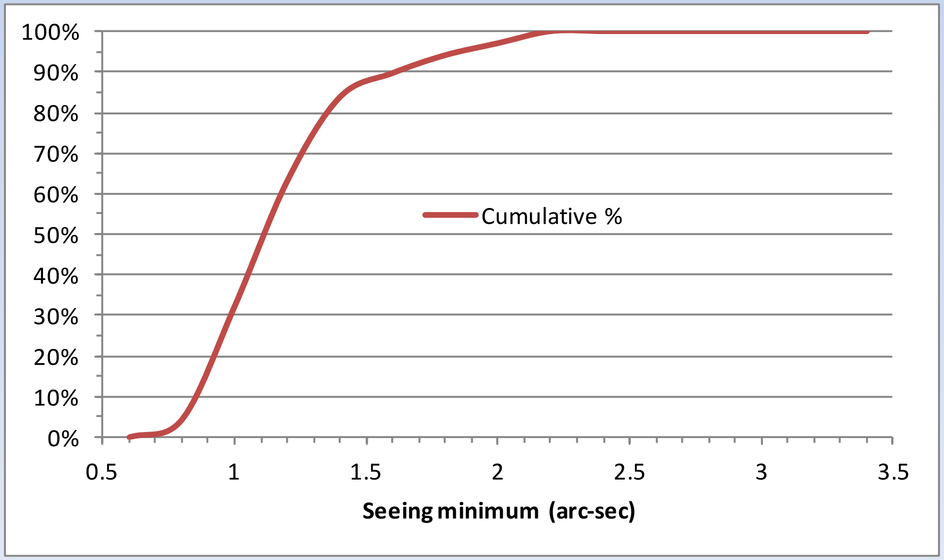
Seeing Average over Night





Seeing Minimums over Night





With a Remote Observatory there are different risks to be concerned

1) Damage equipment
   - Roof not closing in inclement weather causing equipment damage
   - Roof collision with scope
   - Losing communication with telescope that in a worse case leads to telescope collision with pier
   - User not attentive, or over sleeps, or thinks tracking is off, or forgets to park mount…but telescope is still tracking which leads to collision with pier
   - Meridian Flip does not occur, which leads to telescope collision with pier
   - Runaway Scope leading to telescope collision with pier

2) Degrade Equipment life
   - Leaving equipment powered on 24/7
   - No lens cap
   - Repeatedly draining UPS battery
   - Extreme heat or cold outside vendor specifications
   - Equipment moisture protection

With a Remote Observatory there are different risks to be concerned.

1) Damage equipment
    - Roof not closing in inclement weather causing equipment damage
        - **Have a separate Roof UPS for Utility power outage**
        - **Loss of weather info requires Roof closure**
        - **Nice to have backup method to close roof**
    - Roof collision with scope
        - **Roof interior height should be sufficient to close roof with telescope in any position**
        - **Example of why…..In AP yahoo user group post today, loss comm with mount as weather deteriorated and couldn't park mount and roof would not close because scope was not parked**
    - Losing communication with tracking telescope that in a worse case leads to telescope collision with pier
        - **Loss of Telescope communication methods**
            - **Loss of Internet**
            - **Loss of mount to PC comm**
            - **PC hangs**
            - **Windows hangs**
            - **Imaging SW and/or Imaging Script hangs**
            - **Remote SW (i.e., Teamviewer) hangs on remote or on-site computer**

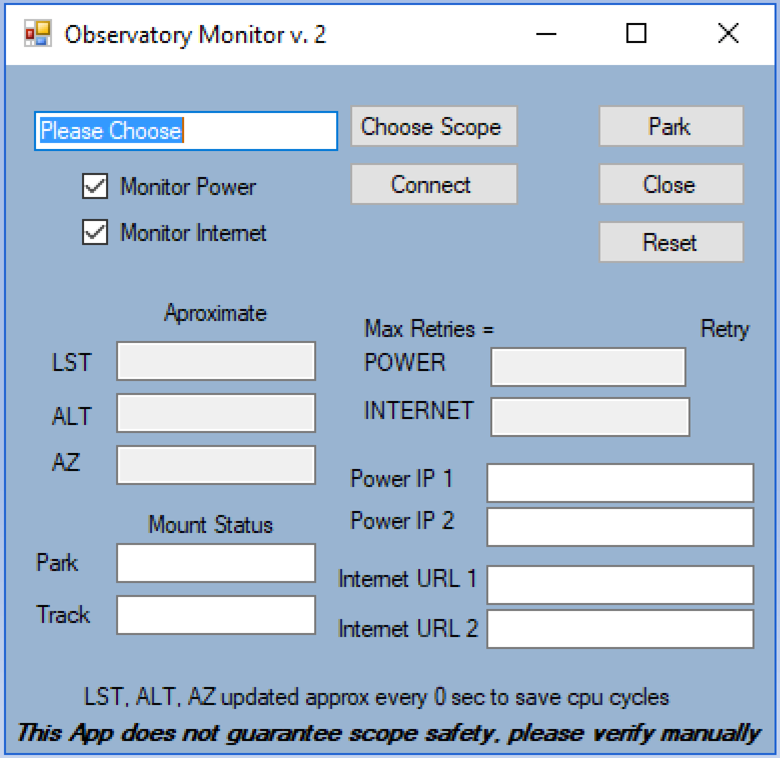
With a Remote Observatory there are different risks to be concerned (continued)

1) Damage equipment (continued)
   - Losing communication with tracking telescope that in a worse case leads to telescope collision with pier (continued)
     - **Loss of Telescope communication methods (continued)**
       - **Loss of Internet**

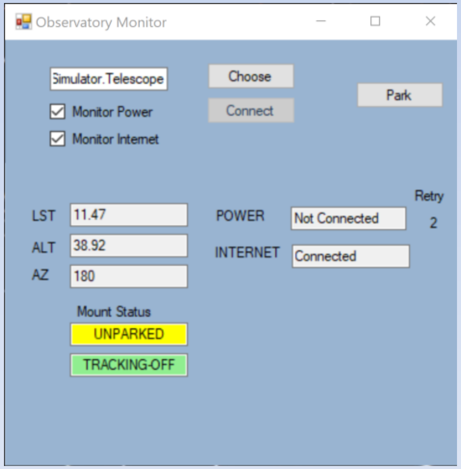
- Remotely we control our telescope components, and start/stop imaging scripts using the internet through software, such as "TeamViewer". If the internet connection is lost for what ever reason, we can't control the telescope. If the telescope is imaging by a script, it will continue until it finishes the script or in the worse case, the script stops but the tracking does not, resulting in the telescope hitting the pier. Hopefully, the script exits normally. But it probably would be better if internet communication is lost, to stop the imaging script and just park the mount. Later we will discuss how to minimize hitting the pier.

- In the following charts is a description of my implementation of monitoring the internet and the utility power going into observatory and scope.

Power/Internet Sensor

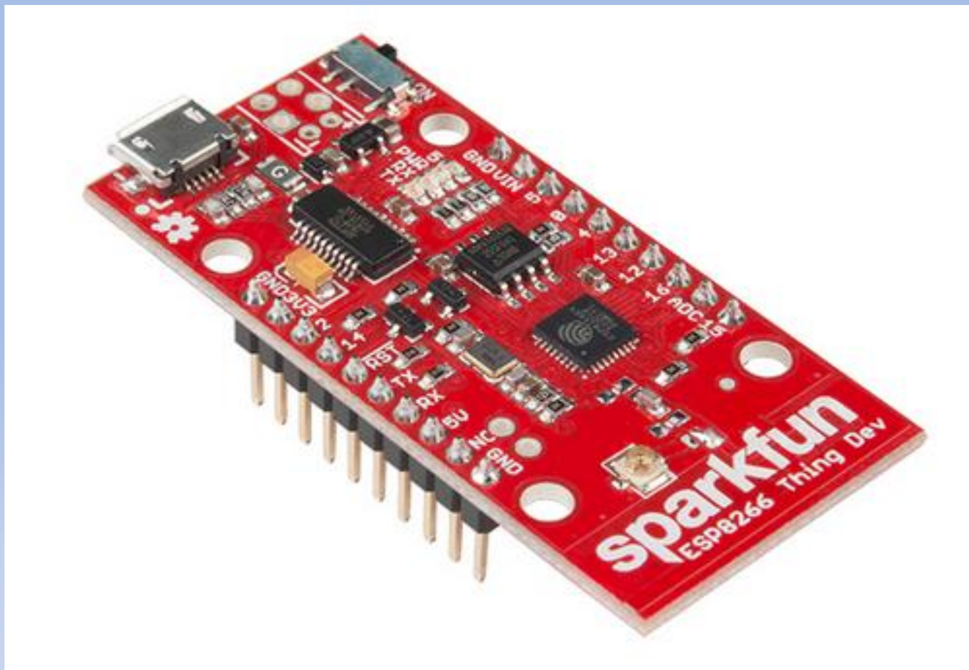


- Software monitors
  - Two redundant sensors for utility power loss
    - If power on both devises is lost on for an user defined number of continuous cycles, mount is parked.
  - Two websites for loss of internet
    - If both internet websites are lost for an user defined number of continuous cycles, mount is parked.

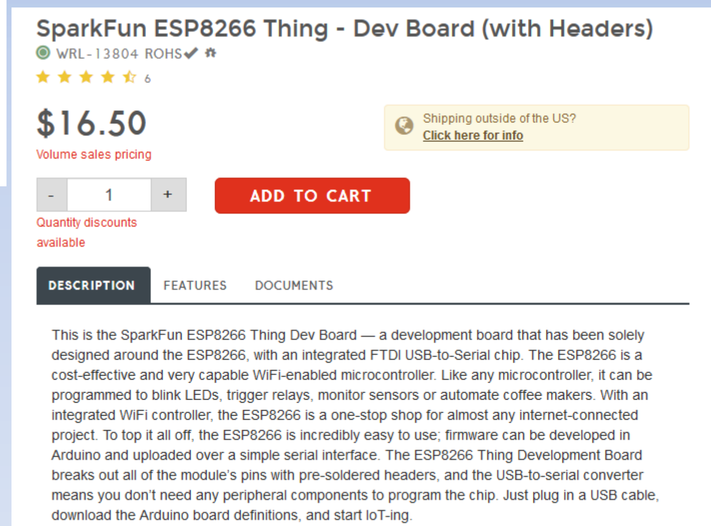


Latest version is color coded
Yellow – one sensor or one internet site down
Red – both sensors or both internet sites are down

Power/Internet Monitor Sensor



Wifi enabled board

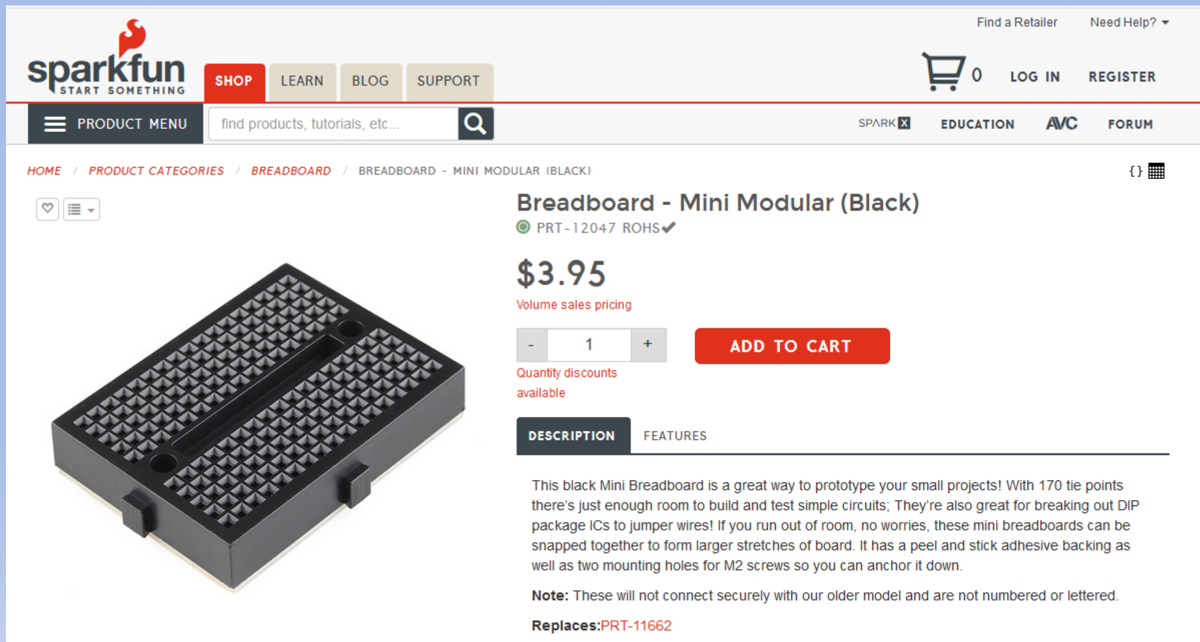


Original developer used this board as his observatory contains only his equipment

Power/Internet Monitor Sensor

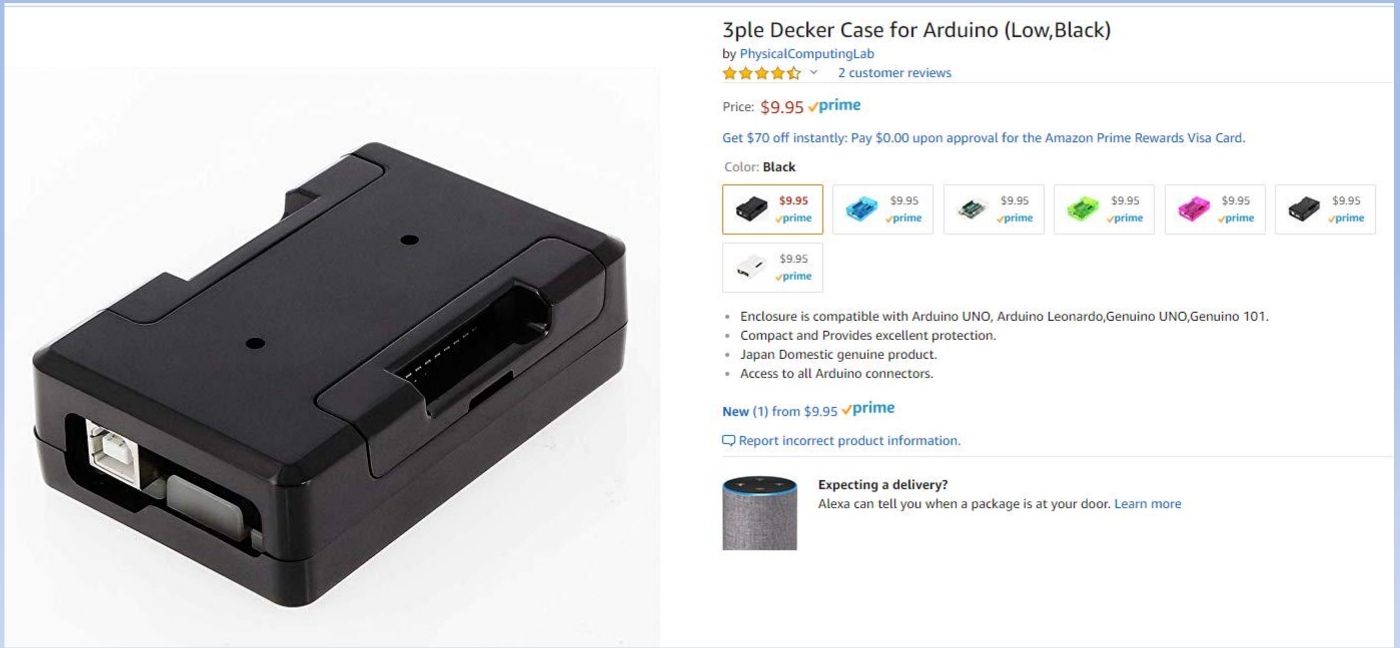
Ethernet enabled board

Since I am in a group observatory, I can not use a wifi card and had to find an Ethernet board



Purchase this if using Wifi enabled board

Purchase this for either board



Case for Board

With a Remote Observatory there are different risks to be concerned (continued)

1) Damage equipment (continued)
   - Losing communication with tracking telescope that in a worse case leads to telescope collision with pier (continued)
     - **Loss of Telescope communication methods (continued)**
       - **Loss of mount to PC comm**

- **The AP mount with CP4 can communicate with the PC by USB, Ethernet, and serial. I use the serial port as the primarily method to communicate with the PC, and use the Ethernet port to communicate with the PC as a backup or use to update mount firmware.**

- **In addition, APCC Pro has feature to park mount if communication between PC and mount stops for a user defined time**

Park mount is used in manual, but believe the mount just stop tracking

With a Remote Observatory there are different risks to be concerned (continued)

1) Damage equipment (continued)
   - Losing communication with tracking telescope that in a worse case leads to telescope collision with pier (continued)
     - **Loss of Telescope communication methods (continued)**
       - **PC hangs**
       - **Windows hangs**
       - **Imaging SW and/or Imaging Script hangs**
       - **Remote SW (i.e., Teamviewer) hangs on remote or on-site computer**

- **If the PC or PC software hangs, than capability to end and restart SW needs to be available, as well as cycle power on the PC. Windows task manager can end SW that has hung.**
- **To be able to remotely cycle power of any hardware component, requires a web power switch or similar. The switch is control through a browser on the telescope PC and the remote PC. Do not use the wireless option if in group observatory.**

Web Power Switch Pro Model

by DIGITAL LOGGERS

12 customer reviews | 4 answered questions

List Price: ~~$199.00~~
Price: $169.00 prime
You Save: $30.00 (15%)

Get $70 off instantly: Pay $99.00 upon approval for the Amazon Prime Rewards Visa Card.

- Rugged, reliable power control over the web. Industrial quality, 15A
- Secure web server with SSL, SSH, HTTPS, SNMP, REST API
- Amazon Echo/Alexis compatible
- Simple web UI, or write your own script or program
- AutoPing feature to reliably reboot routers or APs

With a Remote Observatory there are different risks to be concerned (continued)

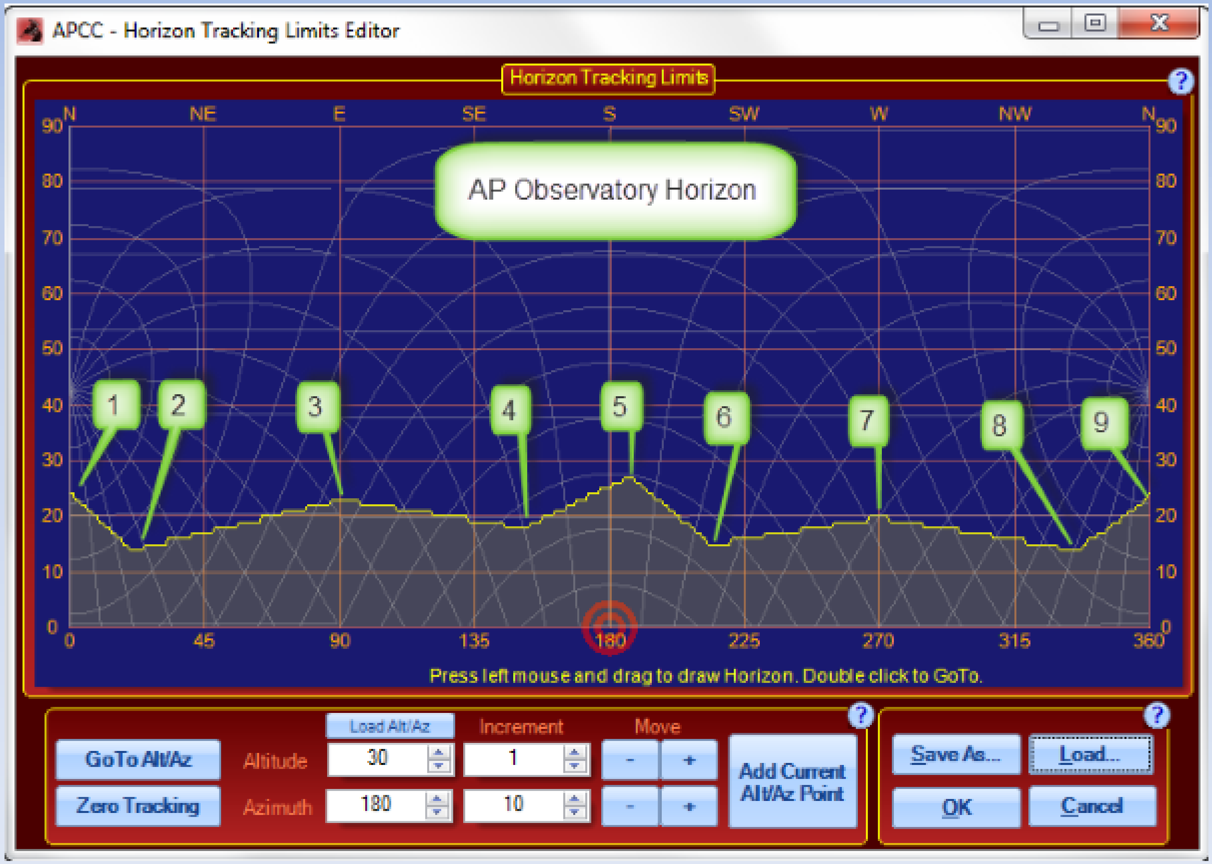
1) Damage equipment (continued)
    - User not attentive, or over sleeps, or thinks tracking is off, or forgets to park mount…but telescope is still tracking which leads to collision with pier

- **There are several other options to minimize hitting the pier.**

    1) **Don't sleep while imaging and when imaging is complete, turn off and confirm mount power is off.**
    2) **If sleeping while using a script to image, get up when imaging script is expected to complete, Astronomical twilight is over or object gets below your minimum elevation and park the mount and turn off power**
    3) **Most imaging script have the capability to automatically check for telescope elevation and stop imaging when a user defined elevation value is reached. When this value is reached I have added actions to do a plate solve, warm up the camera (cooler power to zero), and park the mount.**
    4) **Do options 2 and 3, to protect for setting alarm incorrectly or sleeping through alarm.**

5) There are software packages available to set horizon limits for the mount. When limits are reached, the mount automatically parks itself. Usually these horizon limits are used to set horizon terrain limits when building, mountains or trees location are higher than the horizon. But you can also use to protect scope hitting pier to not allow scope to point below horizon. I use APCC Pro.

APCC Pro Horizon Limit Editor



6) Using options 3 and 5 together needs some discussion. If the imaging script operates properly, then option 5 is not needed. But what happens if the script stops or hangs up. The elevation level will not be protected. So this is where option 5 comes in as the final level to protect the optical tube hitting the pier or tripod. I set the script elevation level to my minimum westerly elevation value of 30 degrees and the APCC elevation limit to 20 degrees. There is still a probability the failure that causes the imaging script to hang could also cause the APCC software to hang.
   - Hardware options are needed to mitigate
     - Mount encoders with firmware elevation limits
     - Limit switches that with contact, cut power
     - Garage door like switches that when optical path broken, cut power

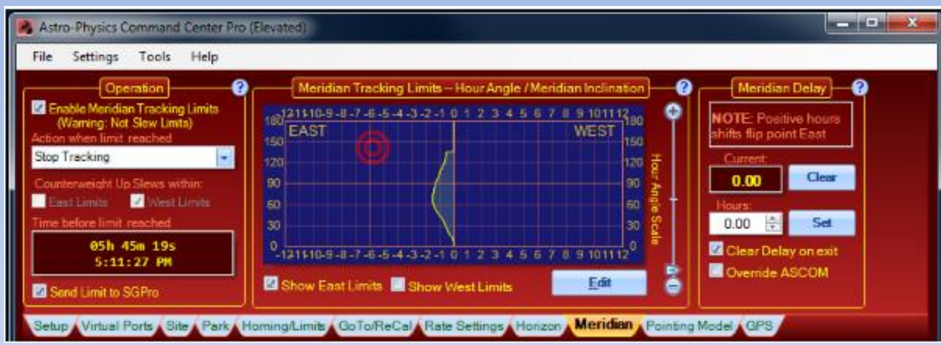
7) So far the discussion has been about parking the mount after imaging is compete. But we can't forget about potential problems that can occur at the beginning of the night. We think the mount is still parked, but it isn't and the mount is tracking. We get sidetracked doing something else and before we know it, we see the mount pointed in a different direction. So if we use park positions that provide the longest possible time before the optical tube hits the pier or tripod. This would give the longest time for the user to recognize that tracking has not stop and to correct the situation.
   - I use Park 4 – counterweights on east side of meridian

With a Remote Observatory there are different risks to be concerned (continued)

1) Damage equipment (continued)
    - Meridian Flip does not occur, which leads to telescope collision with pier

- **When imaging on the east side of the meridian with a German equatorial mount, the user must perform a meridian flip near or shortly after the optical tube reaches the meridian to prevent the optical tube from hitting the pier or tripod. Options to mitigate are;**
    1) **Know the approximate time of optical tube reaching the meridian and initiate a meridian flip and perform a plate solve to re-center the object in the camera field of view**
    2) **Run a imaging script that automatically performs the meridian flip and plate solves afterwards to re-center the object in the camera field of view.**
        - **Note: Have had on one occurrence, the script failed to re-center the object in the camera field of view after the meridian flip. But to date have never experienced a meridian flip not occurring.**
    3) **Combine options 1 & 2 for added safety**

4) **Add a fail safe capability to check how long ago a meridian passage occurred and if longer than a user defined value, park the mount.**
   - **Use APCC Pro software to add a time value pass meridian passage to park mount if meridian flip did not occur within stated time.**



Example shown here. My meridian limits are on west side with limit set at 24 minutes past the meridian. My mount can track for more than an hour past the meridian.

5) **Hardware options discussed previously**

With a Remote Observatory there are different risks to be concerned (continued)

1) Damage equipment (continued)
   - Runaway Scope leading to telescope collision with pier

- **I have experience it at start up at APCC initialization. At the end of the previous night's observing had parked scope in position 4. Everything appear normal during day. However, during the next APCC initialization, the scope took off in declination. Fortunately I was watching and did an emergency stop. Never did find the reason. Only thing I could think of was the parking position was different between the APCC and the mount driver.**
  - **The correction though will be a problem in a remote setup. Required unlocking RA/DEC and having a person hold the scope while commanding the mount to park.**
- **Options are**
  1) **always have real-time user supervision at start up and during large telescope slews using camera.**
  2) **Hardware options discussed previously**

With a Remote Observatory there are different risks to be concerned (continued)

2) Degrade Equipment life (continued)
   - Leaving equipment powered on 24/7

- **Kevin Moorefield told me that all telescope equipment in the SRO group observatories are left on 24/7. The co-owner of DSW has said the same thing to me.**
  - **This make no sense to me, especially leaving the camera fans running.**

- **On the AP forum, a topic similar to this came up. The consensus appears to say the leaving the electronics running during cold weather is best.**

With a Remote Observatory there are different risks to be concerned (continued)

2) Degrade Equipment life (continued)
   - No lens cap

- **At DSW, many of the Takahashi refractor telescopes have a motorized lens cap.**
  - **Having a lens cap attached to a telescope during windy conditions would seem to be not a good idea.**
  - **At DSW , only the larger scopes protrude over the walls and the wind is usually very low. When the wind speed gets gusty the roof closes.**
  - **So the risk of wind effecting telescope tracking with an opened lens cap appears to be low**

- **Larger scope do not use a motorized lens cap, probably due to size and weight.**

- **Having the telescope mirrors get dusty over a period of time has to be accepted, requiring at some time to be cleaned.**
  - **One option to try to minimize dust on mirrors is to leave the scope pointed at the horizon or below the horizon when not in use.**

With a Remote Observatory there are different risks to be concerned (continued)

2) Degrade Equipment life (continued)
    - Repeatedly draining UPS battery

- **When utility power is loss, an UPS battery is used to maintain power for a short period of time. Depending on the number of times the UPS is required and the amount of UPS power drain during each use can over time have an affect on UPS battery life.**
    - **I have been told that with lead acid batteries, you don't want to let get below 50% power drain. Draining the power for the battery below this value will degrade battery life.**
    - **DSW replaces all UPS devices every 2-3 years**

- **Methods to extend UPS battery life will be discussed in the Operational Section.**

With a Remote Observatory there are different risks to be concerned (continued)

2) Degrade Equipment life (continued)
    - Extreme heat or cold outside vendor specifications

AstroPhysics Mounts: Has warning about "SLEWING YOUR MOUNT IN BELOW FREEZING TEMPERATURES ". In the worse case they talk about loss of control. The following are four suggestions to alleviate the problem:

- **First, do not use extension cords between the mount's cord and the DC power source.**
    - **If you must have a long distance between the supply and GTOCPx control box, use a heavy wire to minimize the voltage drop.**
    - **Do not let power drops below about 10.5 - 11 volts at the servo terminal.**
    - **limit the slew speed to 600x during real cold weather to reduce the power demand from the supply.**
- **Second, it is very important to have a properly set worm mesh and to not have it set overly tight. You can check to see if the worm turns easily by removing the motor covers and then rotating the large aluminum spur gear. Try turning it by hand one full turn in each direction. If it does not easily turn, then the motor will also have a difficult time turning it.**
- **Third, under extreme cold temperature conditions (below -20F) it may be necessary to replace the grease on the worm wheel teeth with a lighter material.**
- **Fourth, we recommend using a 15-16 volt power supply (or equivalent) for heavier loads. We have found that the higher voltage improves motor performance when operating under these adverse conditions. Do not exceed 16 volts.**

With a Remote Observatory there are different risks to be concerned (continued)

2) Degrade Equipment life (continued)
   - Extreme heat or cold outside vendor specifications (continued)

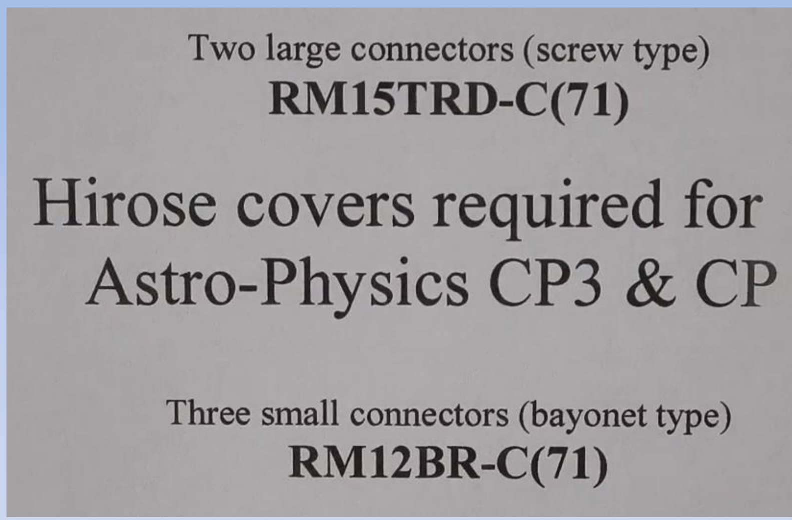
- Checked all my equipment for environmental specifications to compare to DSW expected temperature ranges: Santa Fe @6300 feet : -6 to 100 deg F

  - **Astrophysics CP4 – couldn't find one**
  - **SBIG STF-8300 Camera's – couldn't find one**
  - **UPS - 32°F to 104°F**
  - **Shuttle PC - 0 deg to 50 deg**
  - **WEB Power Switch - -30deg to 170 deg**
  - **Radio Shack Power Supply – couldn't find one**
  - **Astron PS – couldn't find one**
  - **RoboFocus – couldn't find one**
  - **Moonlite Focuser – couldn't find one**
  - **Pegasus - -40°C to +80°C internal chips**

  - Couldn't find the majority of them
    - UPS seems to the component most susceptible
    - Internal electrical components appears to be safest

With a Remote Observatory there are different risks to be concerned (continued)

2) Degrade Equipment life (continued)
   - Equipment moisture protection



Hirose covers

Found connectors covers at www.mouser.com

•Small --- $9.07each

•Large ----$12.90 each

22) Equipment moisture protection (continued)

USB Type B Protective Port Cover, 10 Pack by Generic
Sold by: Cyberguys!
$7.99

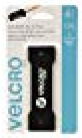
uxcell Black Rubber RJ11 Connector Port Anti Dust Cap Protector Cover 10 PCS
Sold by: uxcell | Product question? Ask Seller
Return window closed on Nov 9, 2018
$6.11

Electrical Connector Covers

RiteAV Dust Cap Anti-Dust Plugs Protective Cover Cap - DP (DisplayPort) Male Connector (10 pack)
Sold by: Ultra Spec Cables (RiteAV®)
Return window closed on Oct 12, 2018
$7.99

CablesOnline 10-Pack HDMI Male Dust Cover Port Protectors, Black (CV-H01-10)
Sold by: AZsales
Return window closed on Oct 12, 2018
$8.49

VNDEFUL 20 Pcs Black Rubber USB A Type Female Anti Dust Cover Protector Plugs Stopper Cover
Sold by: VNDEFUL
Return window closed on Jul 25, 2018
$5.88



VELCRO Brand - ONE-WRAP For Cables, Wires & Cords - 12" x 1 1/2" For Plugs - Black
Sold by: Carmelito
Return window closed on Sep 20, 2018
$6.95

Cigarette Lighter connector wrap - Velcro

With a Remote Observatory there are different Operational concerns

Operational Concerns

1) Loss of Utility Power and return of Power
2) Mount loses home position due to user error
3) Power and/or data hubs fails
4) Cable Management
5) Can't confirm what scope is doing during slews
6) Shooting flats
7) Dew protection
8) Turning on computer remotely
9) Getting subs from remote computer
10) Updating Mount firmware
11) Backup for Mount communication
12) Need for reliable data hub
13) Remote Telescope Communication
14) Windows Update

1) Loss of utility Power and return of power

- Using a UPS battery backup can extend the time necessary to gracefully exit your hardware and software programs before complete loss of power.

- If the power is down for only seconds or a couple of minutes, then the UPS does it job and the system will not notice the loss

- But if the power is down for 30 or more minutes the UPS will eventually drain and the effect is the same as not having an UPS. And it is not good for a battery to be completely drained as can shorten the battery life and require a long trip to replace.

- So ideally, the best remote option is once the telescope is on battery power to have a script to shutdown all programs and power off the telescope components after an user defined time. The biggest power hog is the camera's cooler.

    - Most UPS has the capability to communicate with the PC to provide the power status. Can be setup to send email to user to notify that UPS is on battery. If awake and near PC then user can shut down the system before battery is drained. However, if using a script and the user is not available, the battery will eventually drain in a short period of time (i.e., 10-30 minutes).

1) Loss of utility Power and return of power (continued)

- So now, you get to decide how much you want to protect your system for loss of power. If you believe you only want to have a power backup for 10-30 minutes, the UPS can do that. If you want to protect for a several hour power outage then additional work is required. What is desired?
- The ideal script would be a windows script that is operating outside your telescope systems. The script checks the UPS status, and if on battery, the script tells the imaging script to stop the imaging action. The windows script then warms up the cameras, does a plate solve, parks the mount, exits all running software programs and shuts down all power to equipment except for PC. Its last command is to shut down the PC. The only remaining power draw would be the web power switch. But this would provide the best chance of getting through a power outage for several hours. Of course if power is out for days, then the UPS will be drained and may have to be replaced.
- Most imaging scripts have code to control the camera's cooler and mount, and can check the weather sensor data. So if the weather is bad for imaging, the user can have the script stop imaging and perform camera and mount shutdown commands. So the imaging script has almost all the code that is needed to perform equipment shutdown tasks, if it could be told when to initiate equipment shutdown with a power outage.
    - I use CCD Commander and it does have a capability to run an external script, but doesn't have capability to be commanded by an external script.

1) Loss of utility Power and return of power (continued)

- So four options
    1) Get Image script owner to add capability (Did ask….Said will think about it)
    2) Create a windows script to do everything
    3) Create a simpler windows script to implement the overall intent of the ideal script
    4) Create a hybrid combining the imaging script capability with a simple windows script.
- The first two options would take the longest to implement. The third option, eliminates some of the desire features but meets the intent of the ideal script. And the fourth option, is more complex than option 3) but does provide all the desired script features.
- Option 3)
    - Let's look at the situation if we did nothing with loss of power. If the utility power is lost, all power is instantly removed from the mount, cameras, hubs, focuser, and computer resulting in equipment stoppage. Basically the same thing happens when the power is drained from an UPS battery.
    - So the window's script could be as simple as check to see if utility power is lost, park the mount, and pull power to all telescope equipment after a defined number of minutes have elapsed since utility power loss. This results in the same sequence of events and severity that would happen if nothing was done with a loss of utility power or a drained UPS battery.

1) Loss of utility Power and return of power (continued)

- Another option that is less sever would be to park the mount and stop the camera cooler. This would protect the mount and turn off the largest power consumer, which would extend the time before the UPS power is completely drained.

- Option 4)
  - Use a windows script to overwrite a weather output data file to make the imaging script think that the weather is bad, which stops the imaging action, and then gracefully warms-up the camera, and parks the mount. Then after a timer expires, the windows script could first shut down the power to all equipment except the PC, and then as the last set of actions turn the PC off and the web power switch. This would prevent total power drain from the UPS.

- Currently only a portion of option 3) has been implemented; Parking the mount with power loss occurring after an user defined time.

1) Loss of utility Power and return of power (continued)

- As a side note, I could, not worry about parking the mount. The AP mount with CP4 has the capability that once power is pulled and then power is returned, the mount remembers where it is, but stays at this position until told to park. But adding the code to the windows script to park the mount is trivial, so I think it is better to just park the mount and rely on the AP capability as a last protection.
- The sensor to monitor utility power was described previously

- Return of Power
  - I am conflicted on the direction to go here as there doesn't seem to be a best method.
  - Basically two options: return of power and equipment stays off or power is provided to equipment
  - Ideally, if my power monitor script was completed and had already shut everything off, then I would just prefer to leave everything off when power returns. However, if during the winter, and the electronics should be left on, after power returns the equipment should be powered back on.
  - Currently, with power loss and return, all equipment will be powered up.
    - I do have an easy method to switch so that all equipment will stay off when power returns.

2) Mount loses home position due to user error

- If mount loses the correct location of the home position, then unless you are lucky, you will not be able to align the mount/telescope to the sky and will not be able to find anything even if letting plate solve run for 10’s of minutes.
    - I messed up a star calibration and didn’t know it.   After parking the mount, I found that the scope was not pointed correctly.
    - At a remote observatory, I will not be there to correct, so options are to buy a paramount mount, add encoders or add a two axis digital inclinometer.

level developments

IS-2-30 : 2 Axis Inclinometer Sensor With RS232 Output

www.leveldevelopments.com

Buying Information

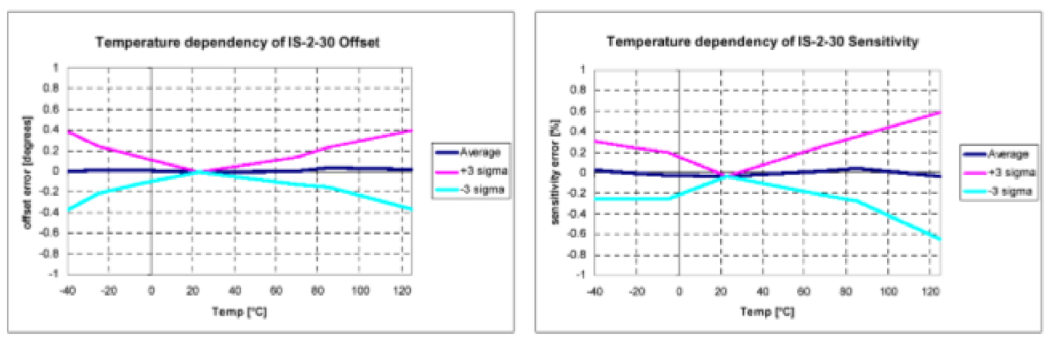
Volume	Unit Price $
1 - 4	150.50
5 - 9	144.50
10 - 24	139.30
25+	POA

Specifications

Range	±30° - Dual Axis
Resolution	0.01°
Accuracy	±0.05° or 1% (whichever is greater)
Output Format	RS232 (ASCII)
Supply Voltage	9-12Vdc
Operating Current	<30mA (@12V)
Cable Length	2m (screened)
Dimensions	43 x 40.5 x 21.5mm
Weight	40g
Operating Temp	-25 to 85°C
Sealing	IP65

The Effect of Temperature on Accuracy

Changes in temperature can cause a zero bias drift, and a change in sensitivity of the output. The graphs below show these errors for typical amd worst case devices.



DB9 RS232 and Power Cable

Part Number: **WR-232-Y18**

Pricing

Quantity	Price
1	$10.90
20	$8.18
50	$5.45

* Contact us about potential lead times.

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Total: $10.90 Qty: 1

www.crystalfontz.com

Description

The DB9 pin Serial RS232 plus DC power connector allows you to bring serial connectivity and power to another device. The way this cable works is that a DB9 serial connection does not use all its 9 pins in the interface with an RS232 cable. Therefore, we designed this cable to piggy-back a power supply so that those previously unused pins now provide 5V power.

Inclinometer mount on bracket

3) Power and/or data hubs fails

- Not much to do here is except replace the unit. In my case because I am using two telescopes, if the hub fails than I lose both scopes. To minimize this, I added three spare cables to the scope harness for the main camera and guider. In addition, the main camera focus cable does not go through the hub. So if I lose the power/data hub, I can get the on-call tech to switch cables and the main camera is again operational.

4) Cable Management

Cable management is critical to ensure the cables doesn't catch on something and pull or strip a connector or in just a minor case ruin a image sub. Generally you will have two harnesses one for the scope and one for the mount. There appears to be four major methods. We will discuss each and some related additional cable management issues.

1) Cable harness with two loop method (one small loop for DEC and one large loop for RA movement; large to small loop length ratio, no more than 3:1)

Scope is pointed due North at 0 deg elevation (AP Park 1 position) in picture

- AP Park 4 position (due South at 0 deg elevation) appears to make cable loop easier to visualize and verify since large loop goes straight from small loop tie down (DEC) to pier. Large loop cable harness is stretched to its longest length in park 4.
- This cable management method keeps cable near center of mount and therefore minimizes heavy cable weight affecting tracking. Downside is harness is close to mount and may be more likely to catch on something. Did have a harness velcro wire wrap stick to the velcro running around pier.

4) Cable Management (continued)

2) Cable through mount method

High-end mounts like the Astro-Physics Mach1 offer the ultimate luxury — through-the-mount cabling. Cables run through the right-ascension axis up through the declination axis and come out under the dec plate.
Jerry Lodriguss

Routing Cables through the Paramount MX and Paramount MX+

[Paramount MX User Guide]

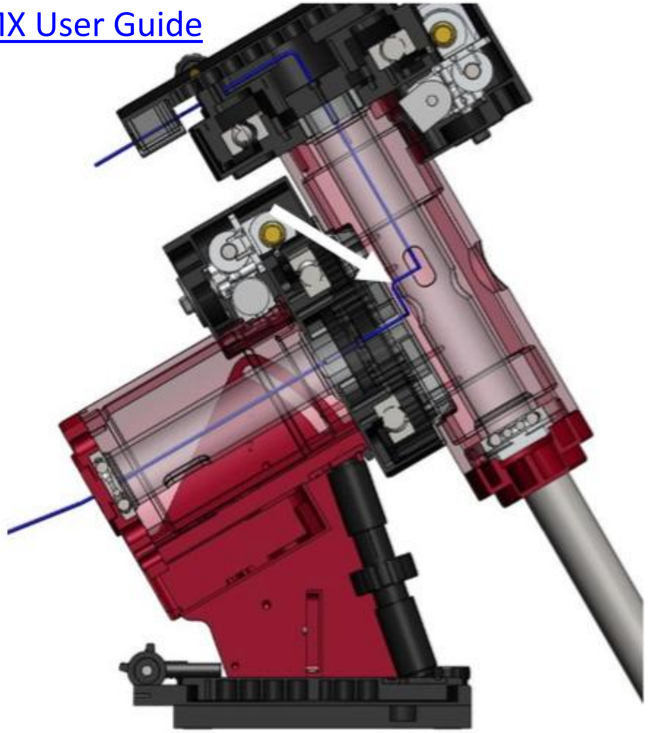


Figure 6: Paramount MX cross section showing path of cable through the mount.

4) Cable Management (continued)

3) Cable harness on rear of dovetail behind/below camera (one loop method)

- Haven't try this, but looks simple. Only concern I would have is if cable harness is large with many cables (thick and heavy) may affect tracking).
- But does keep harness away from mount to minimize snagging on something

4) Cable harness with small loop for DEC movement, than down RA axis along counterweights with loop over to pier. Looks simple, but same concern as above for large and heavy harnesses. Also does keep harness away from mount to minimize snagging on something

4) Cable Management (continued)

5) To minimize the number of cables consider putting data and/or power hub on Optical tube assembly.
    - Generally, a telescope needs two harnesses; one to optical tube assembly and one to the mount.
        - Optical tube assembly (5 or 6 cables)
            - Power and USB to main imaging camera (2)
            - USB to guide camera (1) unless using ST4 port where there would be an additional cable going to the mount
            - Focuser cable (1)
            - Dew heater (1)
        - Mount (2 cables)
            - Power to mount (1)
            - Mount data cable (1)
    - In my case I have two telescopes on the mount, so I have twice as many cables.
        - It became obvious that to make this work I needed to reduce the number of cables. Only really three ways to do this;
        - Moving USB data hub and/or power hub separately to optical tube assembly, use a combine USB data/power hub device or moving everything up with a PC that already includes a USB data/power hub.

4) Cable Management (continued)

5) To minimize the number of cables consider putting data and/or power hub on Optical tube assembly. (continued)

RR-4008-C RIGRUNNER 4008 DC Power Panel Complete
by West Mountain
1 customer review

Price: $144.94 & **FREE Shipping**

Get $70 off instantly: Pay $74.94 upon approval for the Amazon Prime Rewards Visa Card.

Note: Not eligible for Amazon Prime.

EAGLE2, control unit for telescopes and astrophotography

10 Review(s) | Add Your Review

Product code: EAGLE2

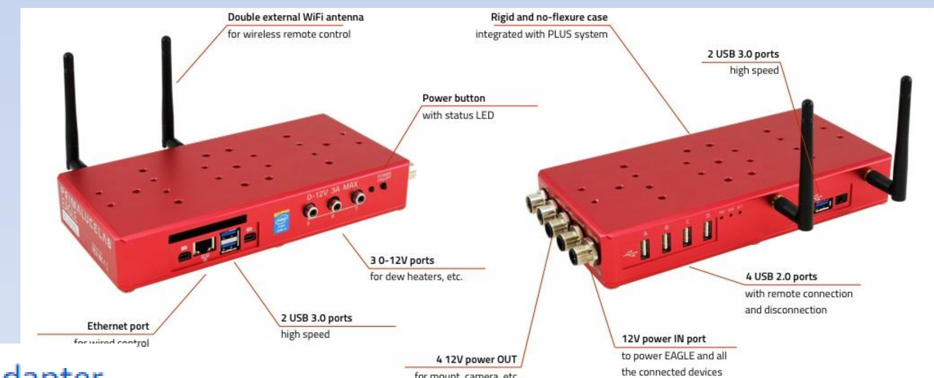
EAGLE2 combines, in one device, a powerful (not a miniPC!) computer with Windows 10 Enterprise operative system (more stable and compact version than normal computers) to the most advanced power management system for telescopes to allow you to make astrophotography easier and quicker! Thanks to integrated WiFi system you can control the entire telescope remotely from your smartphone, tablet or external computer (also Mac) and the special PLUS aluminum case can be connected in various ways to your telescope, always with maximum rigidity.

Availability: In stock

€1,490.00

22% tax incl

if you pay by bank transfer €1,445.30



AmazonBasics 7 Port USB 3.0 Hub with 12V/3A Power Adapter
by AmazonBasics

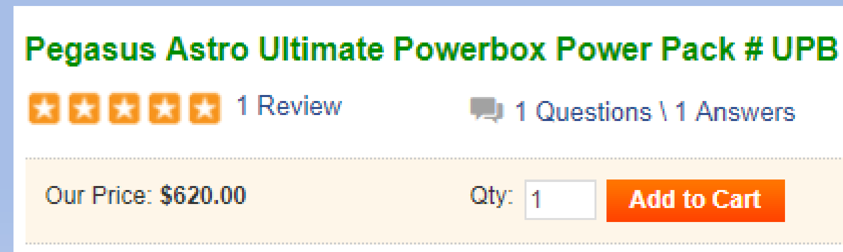
$31.49 prime | FREE One-Day

FREE Delivery by **Tomorrow, Nov 8**

Get it tomorrow for FREE on qualifying orders over $35

4) Cable Management (continued)

5) To minimize the number of cables consider putting data and/or power hub on Optical tube assembly. (continued)



4 - 12v DC outputs
2 - Dew heaters outputs
6 - USB 2 outputs
1 - focuser control output

Of all the options, I choose the Pegasus USB data/power hub

- Computer option very expensive, didn't want to add all that weight and a big heat source up on the optical tube. Didn't have focuser control, and only one Ethernet port. (cables: power (1), Ethernet(1), focuser (2), mount (1) = total 5)
- Individual USB data and power hub was hard to find a room and location on the optical tube with two scopes, plus didn't want to change all the power cables to support Anderson power poles. (cables: power(2), data (1), Ethernet, focuser (2) = total 6)
- Pegasus would connect via existing finderscope bracket on scope. (cables: power(1), data (1), focuser (1) = total 3)

Pegasus Data/Power Hub

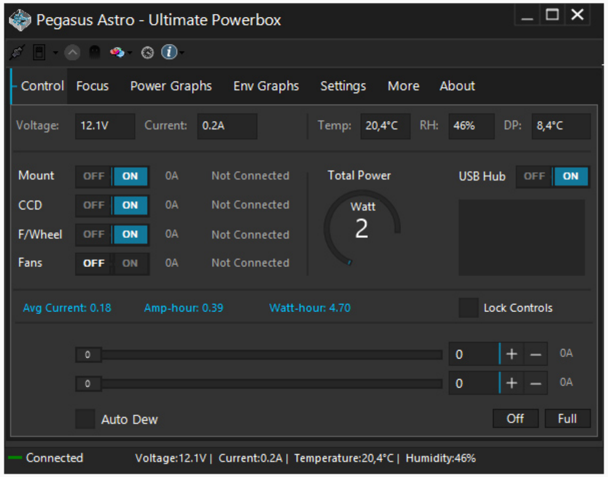
- 4- 12v Outputs
- 2- Dew Heaters
- 12v DC In
- 6 USB 2
- 1 Focuser port
- 1 temp/humidity sensor

Details | **Technical Specifications** | In the box | Accessories | F.A.Q | Documentation / Software | Order | User Shots

Supply Voltage	12V DC (Reverse Polarity Protected)
Power Input Connector	DC 2.5mm
Connectivity	USB2 – Type B USB Connector
4 x 12 Outputs	Maximum Current 7A each. 2.1mm Center Positive Software: ON/OFF
2 Channel x 12 PWM Outputs	Maximum Current 7A Each, Black Colored RCA Connector, Pulse Width Modulated (Suitable for Dew Heaters or Flatbox) Software: Duty Cycle % / OFF
1x Sensor Input	Mini Stereo Socket, Connectivity with Environmental Sensor 0–100% humidity readings with 2–5% accuracy -40 to 80°C temperature readings ±0.5°C accuracy
Ampmeter	Measures 0 – 30A
Voltmeter	Measures 5 – 15V
High Speed (USB2) Industrial 7 port powered Hub	Industrial Chip: Temperature range -40°C to +80°C 6 x High Speed (USB2) available ports USB Hub can switch ON/OFF on demand (software command) 6th USB port can deliver up to 3Amps
Stepper Motor Controller	Unipolar stepper motors, max 1.6 Amps (0.8 Amps per phase) Auto Recover Fuse In case current is higher RJ45 socket / RJ12 – older enclosure)
Dimensions	12cm x 10cm x 3cm (4.72 inch x 4.06 inch x 1.2 inch). Weight is 400 grams (14.1 ounces).

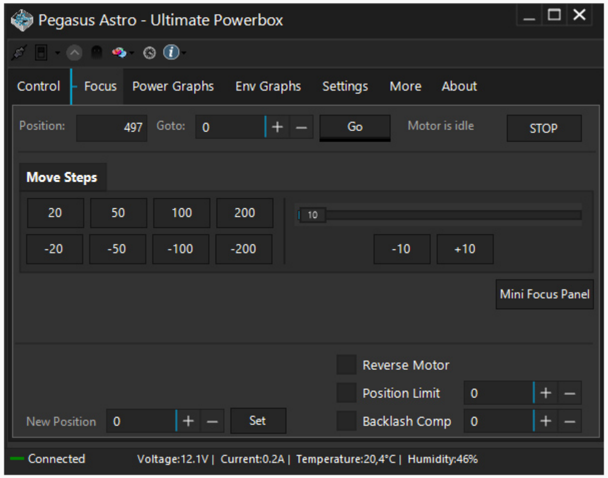
Stand Alone Software

Our modern standalone software has a neat dark skin! Control all Ultimate Powerbox features from this software. Receive metrics, View and zoom into graphs, name your outputs, tune every setting of your Ultimate Powerbox quickly and easily.



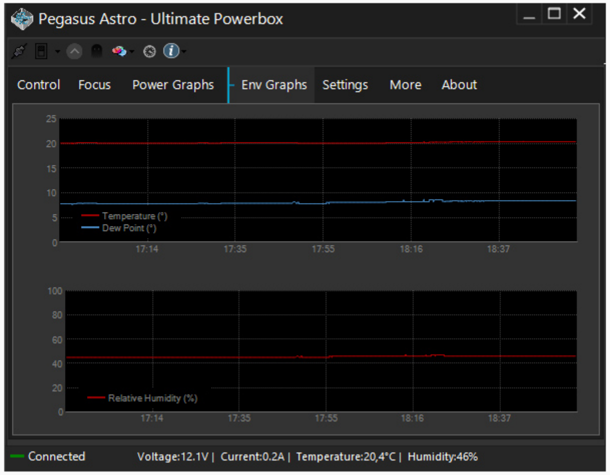
Embedded Stepper Motor Controller

A stepper motor controller will precisely move your focuser. Connect a Pegasus Unipolar Motor or another motor in the market e.g. Rigel, Robofocu, Moonlight Motor. Backlash compensation is already implemented in the firmware and can be enabled, tuned or disabled from the software. A fully ASCOM6 focuser driver is already available.



Zoomable and Exportable Graphs for Power and Environment values

Software logs all voltage, current, temperature and relative humidity readings. All these plots are zoomable and easily exportable in PNG image & CSV text format. Keep a full record of your night conditions.



External Environmental Sensor

External one (1) meter temperature & relative humidity sensor is **included** in the package. Know exactly the environment conditions of your location. Temperature, humidity and dew point measurements are displayed in the software.

Ontario Telescope
and Accessories

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ADD TO WISH LIST   ADD TO GIFT REGISTRY   EMAIL A FRIEND

Share |

Ultimate Powerbox

Your Price: $669.99

Ultimate Powerbox

Part Number: UPB

Availability: In Stock

CHOOSE OPTIONS

Options

- Stepper Motor (universal) with Cable [+$145.00]
- Stepper Motor (SCT) 6,8,9.25" [+$210.00]
- Stepper Motor (SCT) C11 [+$210.00]
- Stepper Motor Cable [+$19.98]
- Skywatcher EQ-8 Power Cable [+$19.98]
- Skywatcher EQ-6R / AZ-EQ6 Power Cable [+$19.98]
- Mounting Brackets [+$39.99]

However, I discovered some issues and a problem occurred with the Ultimate Pegasus

POWER INPUT

Controller can accept voltage ranges from DC 9V – 15V. We strongly recommend to use a branded linear or low ripple power supply unit of **12V DC**. A 13.8V lead (or calcium/lead) battery is also recommended. Please use a power supply that can provide at least 6 Amps of current. For your observatory needs you might need 10-15Amps of current.

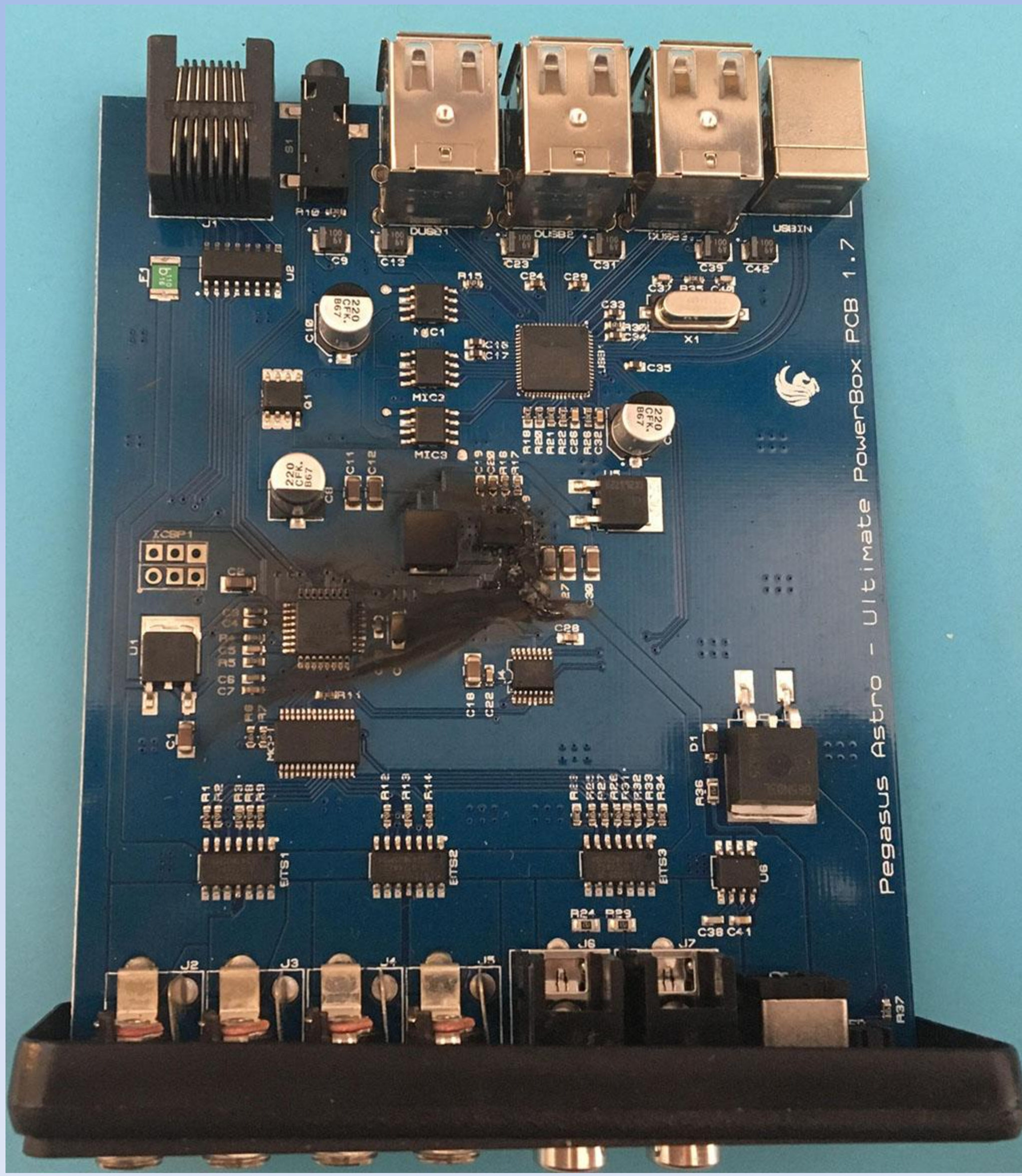
Unit has been designed with reverse polarity protection. If you accidentally reverse the power source polarity, the unit will cut the power. The controller is fitted with a 2.5mm centre positive DC power connection which powers on the unit.

<u>Misleading marketing</u>

- Manual says use 9v-15 v DC Input
  - However, can't get 12v out, if use <12v
  - Unit cuts off above 14v
- Use power supply with at least 6 amps…..may need 10-15amps of current…..capable of up to 20 amps
  - Unit comes with a 10 amp fuse
  - Input cable is only 6 feet and only 18 awg cable (general not sufficient for 20amps)

Turns out using a standard wire sizing calculator that with 15v in, to provide 20 amps and 12 v out, need 6 feet of cable of 18 awg wire

And then …. The Big Burn!



- Pegasus Manufacture claims unit was subjected to over 20 volts to burn like this.

- 13.8v 20 amp Linear Power supply manufacture said power supply had a 17 volt cutoff.

- Pegasus unit was repaired with a new board

- Reduced power supply voltage to 12.8 v (With cooler running full power, voltage is 12.4 v). Wanted a slightly higher voltage than 12 since unit will see colder temps and provide a larger margin for the Pegasus cutoff of 14 volts.

- No problems since, but don't have many hours on it.

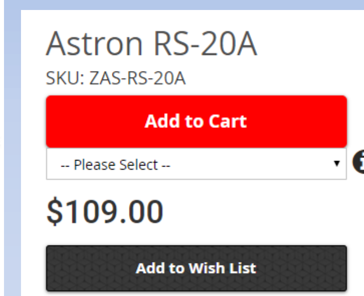
4) Cable Management (continued)

5) To minimize the number of cables consider putting data and/or power hub on Optical tube assembly. (continued)

Needed a power supply for Pegasus, bought the astron 13.8v 20amp linear power supply

- Derated it to 12.8v

Astron RS-20A



- 13.8V Linear Power Supply
- 20A Surge
- 16A Continuous
- Ripple less than 5 mv peak to peak (full load and low line)
- 5x9x10.5”
- 18 lbs
- 17v cutoff

4) Cable Management (continued)

5) To minimize the number of cables consider putting data and/or power hub on Optical tube assembly. (continued)

- With the Pegasus burn experience and only a few hours with new board, I decided that I needed a backup power plan in case Pegasus died again resulting in loss of use of both scopes and having to make a 1800 mile round trip.
  - Added three cables to Optical tube harness to provide power/data to main camera and guide camera. These three cables were not connected but left as spares. Now if Pegasus dies, I can get observatory site owner or tech person to switch cables and the main scope can be back up and running without making the long trip to DSW
    - Side note: Pegasus is providing focus commands to small telescope. Main camera focus commands are provided by robofocus via the optical tube harness. So loss of Pegasus will not affect main scope ability to focus.

4) Cable Management (continued)

   6) Heard reports of critters crawling up pier harness and setting up a nest in mount.
      - May want to take cables up inside of pier and plugging any pier holes.

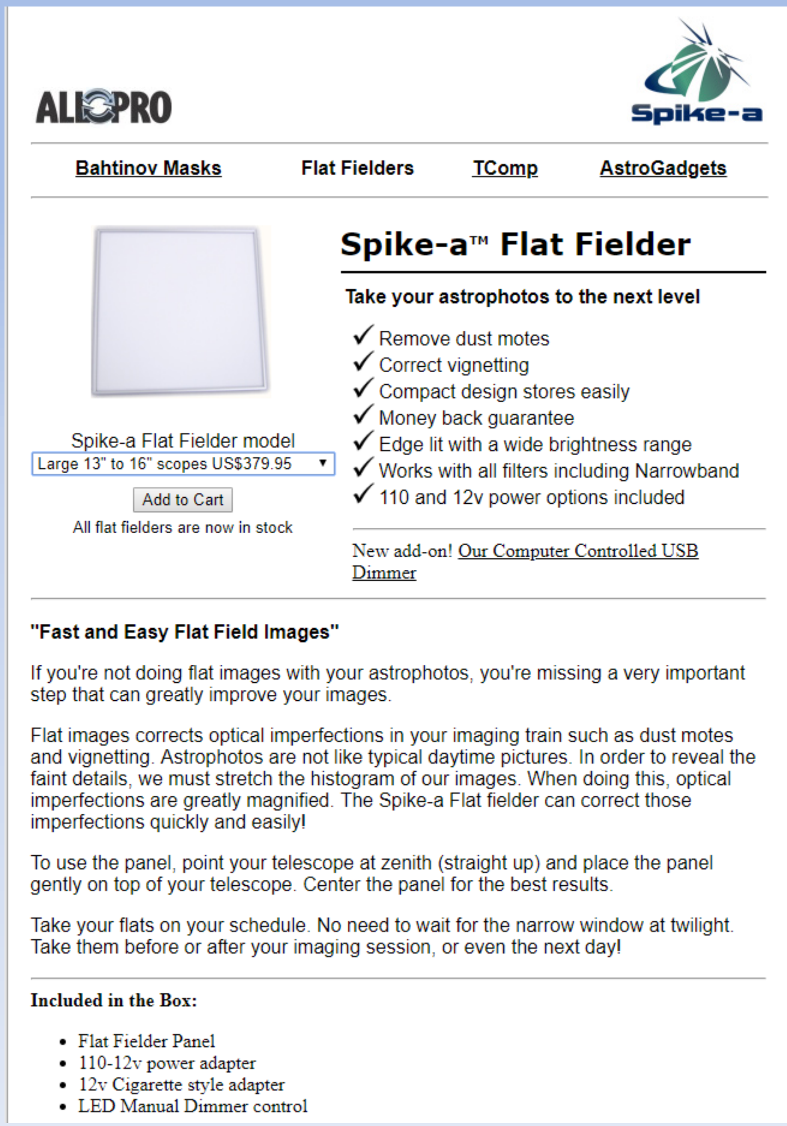
   7) Minimize optical tube harness catching on AP RA lock knobs and one knob holding the two halves of the mount together
      - Changed out knobs on harness side of mount for allen set screws

5) Can’t confirm what scope is doing during slews

- Need to add a camera to be able to check scope position during slews. DSW provides this.
  - APCC pro has simulated telescope motion that can be observed, but I prefer see real motion.

6) Shooting flats

- Two options in a remote observatory; Shoot twilight flats or use a flat light panel with PC control.   Will need an easel or stand to hold panel.



ALLPRO — Spike-a

Bahtinov Masks | Flat Fielders | TComp | AstroGadgets

Spike-a™ Flat Fielder

Take your astrophotos to the next level

- ✓ Remove dust motes
- ✓ Correct vignetting
- ✓ Compact design stores easily
- ✓ Money back guarantee
- ✓ Edge lit with a wide brightness range
- ✓ Works with all filters including Narrowband
- ✓ 110 and 12v power options included

Spike-a Flat Fielder model

Large 13" to 16" scopes US$379.95

Add to Cart

All flat fielders are now in stock

New add-on! Our Computer Controlled USB Dimmer

"Fast and Easy Flat Field Images"

If you're not doing flat images with your astrophotos, you're missing a very important step that can greatly improve your images.

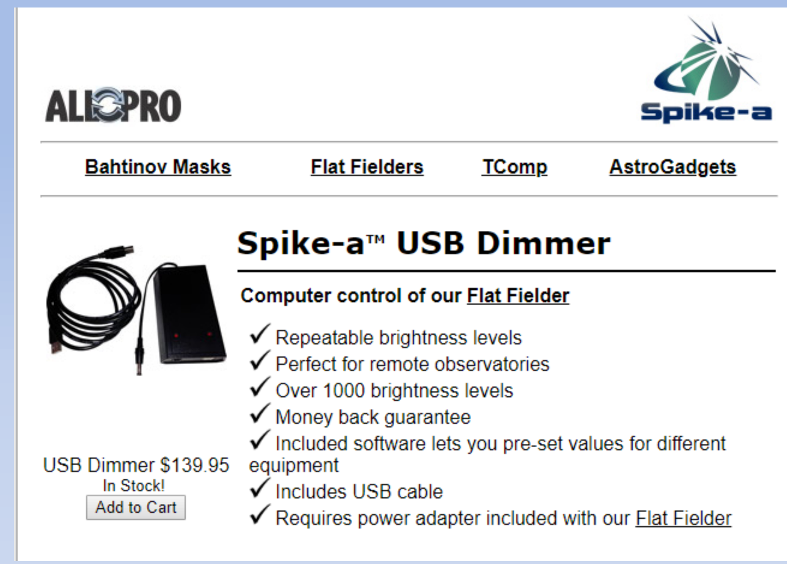
Flat images corrects optical imperfections in your imaging train such as dust motes and vignetting. Astrophotos are not like typical daytime pictures. In order to reveal the faint details, we must stretch the histogram of our images. When doing this, optical imperfections are greatly magnified. The Spike-a Flat fielder can correct those imperfections quickly and easily!

To use the panel, point your telescope at zenith (straight up) and place the panel gently on top of your telescope. Center the panel for the best results.

Take your flats on your schedule. No need to wait for the narrow window at twilight. Take them before or after your imaging session, or even the next day!

Included in the Box:

- Flat Fielder Panel
- 110-12v power adapter
- 12v Cigarette style adapter
- LED Manual Dimmer control



ALLPRO — Spike-a

Bahtinov Masks | Flat Fielders | TComp | AstroGadgets

Spike-a™ USB Dimmer

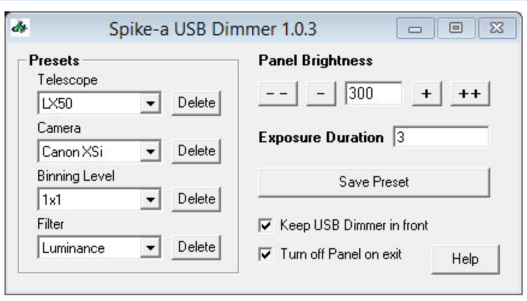
Computer control of our Flat Fielder

- ✓ Repeatable brightness levels
- ✓ Perfect for remote observatories
- ✓ Over 1000 brightness levels
- ✓ Money back guarantee
- ✓ Included software lets you pre-set values for different equipment
- ✓ Includes USB cable
- ✓ Requires power adapter included with our Flat Fielder

USB Dimmer $139.95

In Stock!

Add to Cart



Included in the Box:

- USB Dimmer control unit
- 6 ft USB cable
- USB Dimmer Software - Download the latest version here

7) Dew protection

- DSW generally has very low humidity, and closes the roof with high humidity conditions
    - However, I decided to get a custom dew shroud from astrozap for my 12” RC and made a ring adapter to attach to front bulkhead. Note the RC telescope rear and front bulkhead are of different diameters. Dew shroud extends 6” beyond end of telescope or about 10-12” past the front of the secondary mirror.
- A different option is a dew heater for RC telescopes

KENDRICK RC OPTICS HEATERS

GSO RC Secondary Mirror Heater

These heaters are designed to fit behind the mirror of "tube versions" of GSO RC-8, RC-10 and RC-12 Ritchey Chretien telescopes. It is a flexible, split ring design, which makes it very easy to install. It fits onto the back of the secondary mirror housing and is held in place by silicone glue (user provided).

The Heater is thermally insulated with 1/8" (3mm) thick neoprene sponge foam. The foam is bonded to the heater. The foam will help the heater to direct the heat into the secondary mirror housing and aid in preventing excessive heat loss into the atmosphere and giving better heater performance.

Will this heater work on the new Truss-Tube" models? We aren't sure, but we would love for someone who owns one to drop by our shop for a fitting. We have 1 report from a customer who has a 12" Truss-Tube model who reports that the design of the spider/mirror assembly changed and the gap between the spider vanes and mirror housing is now too narrow for the heater to fit as intended. Our best advice is to make some careful measurements and consult the specs. shown above.

Tech Specs:

- 12 vdc, 5 watts, .4 amps
- Outsidth width...3.5" (90 mm)
- Inside width...2.625" (65 mm)
- Overall thickness...0.195" (4.85 mm)
- Wire length...18" (460 mm)

Installation Sheet Instructions for #2028-GSO Heaters (PDF)

Heater installs here

SKU	Description	Price
2028-GSO	90 mm, flexible, thermally insulated Secondary Mirror Heater	CAN $106.00 US $80.91 ADD TO CART

Right diameter for 10”, I found it to be small for the 12”

With special request you can order copper tape to replace the wires. Tape attaches to spider vanes making it a lower profile than the wires.

8) Turning on computer remotely

- For all computers like desk or laptops, the computer can be commanded to power up with changes to the computer bios.

Wake-on-LAN (WOL) is an Ethernet **computer**networking standard that allows a shut-down**computer** to be turned on **remotely**. Most recent motherboards that have an integrated Ethernet controller that supports this feature. You can enable the Wake-on-LAN feature in the **Power** Management section of the motherboard's BIOS.

https://www.raymond.cc/blog/how-to-remotely-turn-on-computer-from-lan-and-wan/

- However, with the Shuttle PC that I purchased, I just had to remove a jumper from the motherboard to remotely power up with the application of power.

9) Getting subs from remote computer

- Use Google drive.

10) Updating Mount firmware

- The AP CP4 has the capability to update the mount’s firmware using an ethernet cable connected to the PC.

11) Backup for Mount communication

- The AP mount with CP4 can communicate with the PC by USB, Ethernet, and serial. I use the serial port as the primarily method to communicate with the PC, and use the Ethernet port to communicate with the PC as a backup or use to update mount firmware.

12) Need for reliable data hub

- Most of us, use a USB data hub to connect all of our USB devices and use USB-to-RS232 adapters for the serial connection needs. This is usually because our laptops have limited USB and serial ports. However, there are PC's that have numerous ports that will eliminate the need for USB-to-RS232 adapters and USB data hubs.

Shuttle XPC Slim DH170 Mini Barebone PC Intel H170 LGA 1151 Kabylake/Skylake Heatpipe Cooling Module No CPU No Ram No HDD/SSD No OS

by Shuttle

55 customer reviews | 63 answered questions

Price: $248.99 ✓prime

Coupon ☐ Save an extra $2.49 when you apply this coupon. Details

Get $70 off instantly: Pay $178.99 upon approval for the Amazon Prime Rewards Visa Card.

Note: Available at a lower price from other sellers, potentially without free Prime shipping.

Style:

DH170

Service: **Get professional installation** Details

Without expert installation | Include installation +$80.43 per unit

See more

- Form Factor: 1.3L chassis
- Support Skylake CPUs: i3/i5/i7/Celeron/Pentium 65W Socket LGA1151 CPUs
- 4 x USB 2.0; 4 x USB 3.0
- Supports maximum total size of 32 GB (max. 16 GB per module), 1333/1600 MHz RAM (2 x SODIMM)

4 USB 3
4 USB 2
2 Serial DB9 RS-232
2 Ethernet
1 HDMI
2 Display ports

Intel Core i3-7100 7th Gen Core Desktop Processor 3M Cache,3.90 GHz (BX80677I37100)

by Intel

153 customer reviews | 126 answered questions

Price: $158.30 & **FREE Shipping**

Get $70 off instantly: Pay $88.30 upon approval for the Amazon Prime Rewards Visa Card.

Note: Not eligible for Amazon Prime.

Style: **Processor**

Processor	Processor + Gigabyte Motherboard
$158.30	- -

Service: **Get professional installation** Details

Without expert installation	Include installation +$82.84 per unit

See more

- Lightning responsiveness. Graphics Base Frequency 350 MHz
- Work effortlessly
- Security protection

Compare with similar items

New (26) from $158.30 & FREE shipping.

Report incorrect product information.

Crucial 8GB Single DDR3/DDR3L 1600 MT/S (PC3-12800) Unbuffered SODIMM 204-Pin Memory - CT102464BF160B

by Crucial

8,304 customer reviews | 1000+ answered questions

List Price: ~~$75.99~~
Price: $56.30 prime | **FREE** One-Day
You Save: $19.69 (26%)

Get $70 off instantly: Pay $0.00 upon approval for the Amazon Prime Rewards Visa Card.

Note: Available at a lower price from other sellers, potentially without free Prime shipping.

Capacity: **8GB**

2GB | 4GB | 4GB KIT (2GBx2) | 4GB DDR3L | **8GB** | 8GB KIT (4GBx2) | 8GB Kit (4GBx2) 1600 MT/s | 16GB kit (8GBx2) | 16GB 1600 MT/s | 32GB Kit (16GBx2)

Service: **Get professional installation** Details

Without expert installation	Include installation +$78.02 per unit

See more

- Increases system performance.
- Easy to install.Unbuffered:Most PCs and workstations use unbuffered memory which is faster than registered memory.
- Premium quality memory from a trusted brand.
- Laptop/Notebook dual voltage 1.35V/1.5V memory.
- x4Gb based part uses newer technology.

Crucial MX500 250GB 3D NAND SATA 2.5 Inch Internal SSD - CT250MX500SSD1(Z)

by Crucial

1,382 customer reviews | 677 answered questions

Price: $54.95 prime | **FREE** One-Day

Get $70 off instantly: Pay $0.00 upon approval for the Amazon Prime Rewards Visa Card.

Capacity: **250GB**

1TB 2TB **250GB** 500GB

Style: **Frustration Free Packaging**

Frustration Free Packaging Standard Packaging

Service: **Get professional installation** Details

Without expert installation Include installation and data transfer +$92.30 per unit

See more

- Sequential reads/writes up to 560/510 MB/s and random reads/writes up to 95k/90k on all file types
- Accelerated by Micron 3D NAND technology
- Integrated Power Loss Immunity preserves all your saved work if the power unexpectedly gets cut
- Crucial 5-year limited warranty
- Product ships in Amazon Certified Frustration Free Packaging (may differ from retail packaging depicted in product collateral)

Compare with similar items

Used & new (2) from $46.71 prime

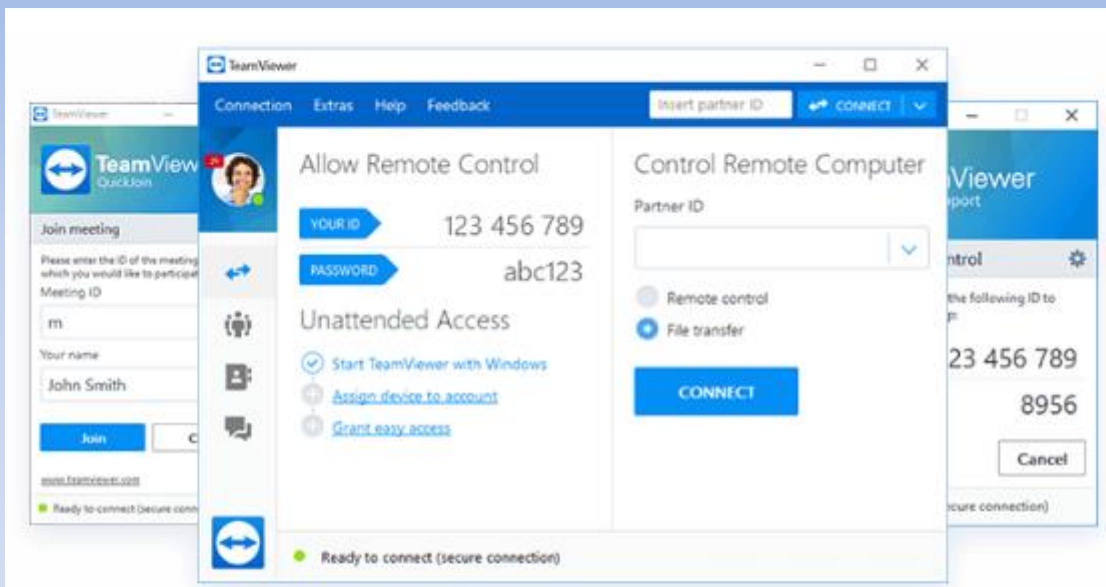
Report incorrect product information.

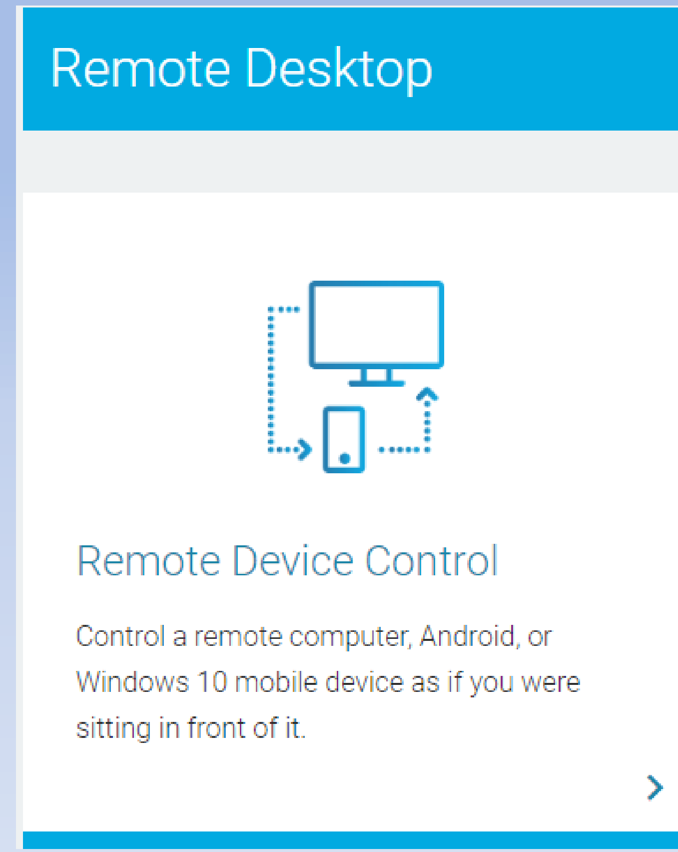
Item arrives in packaging that reveals what's inside. To hide it, choose **Ship in Amazon packaging** at checkout.

13) Remote Telescope Communication

- To be able to communicate with the remote telescope requires internet and software tool.

TeamViewer





Backup: Chrome Remote Desktop

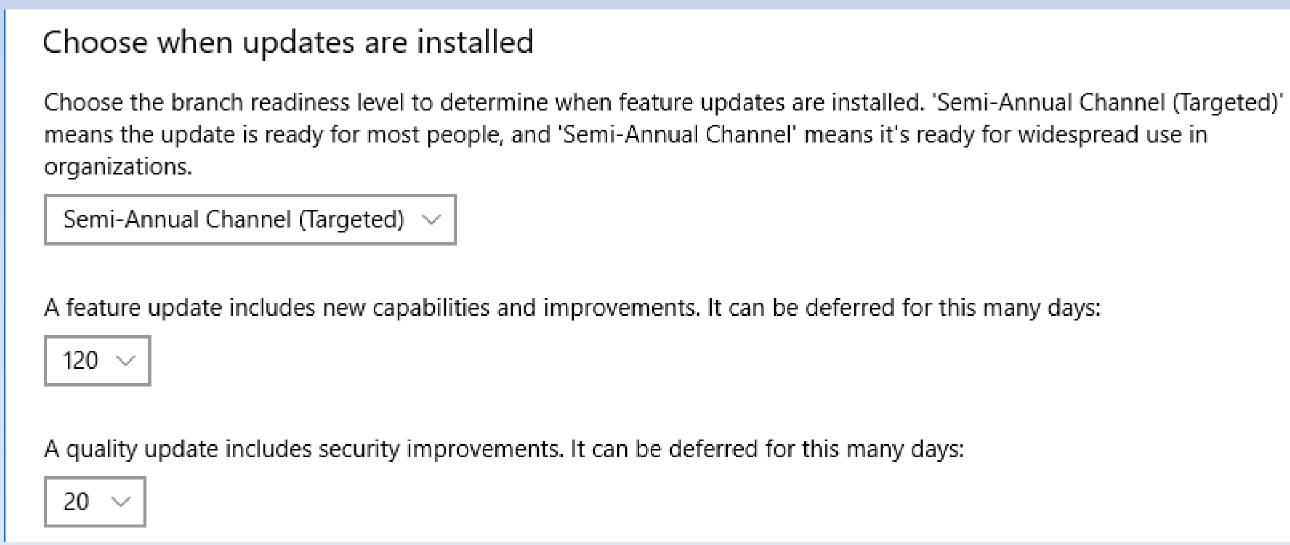
14) Windows Update

Having to deal with a windows update at the wrong time can really cause delays in getting an image.

However, there is a procedure that has worked well for me.

- At start of observing session, go to “PC settings” and then “Update and Security”, and finally “Advanced Options”. Go to “Pause Updates” and turn off. After my observing session is over, I turn “Pause Updates” back on.

- It has been known that Microsoft sometimes uses the User as their Beta tester.
- To not be an early guinea pig it has been suggested to do the following…



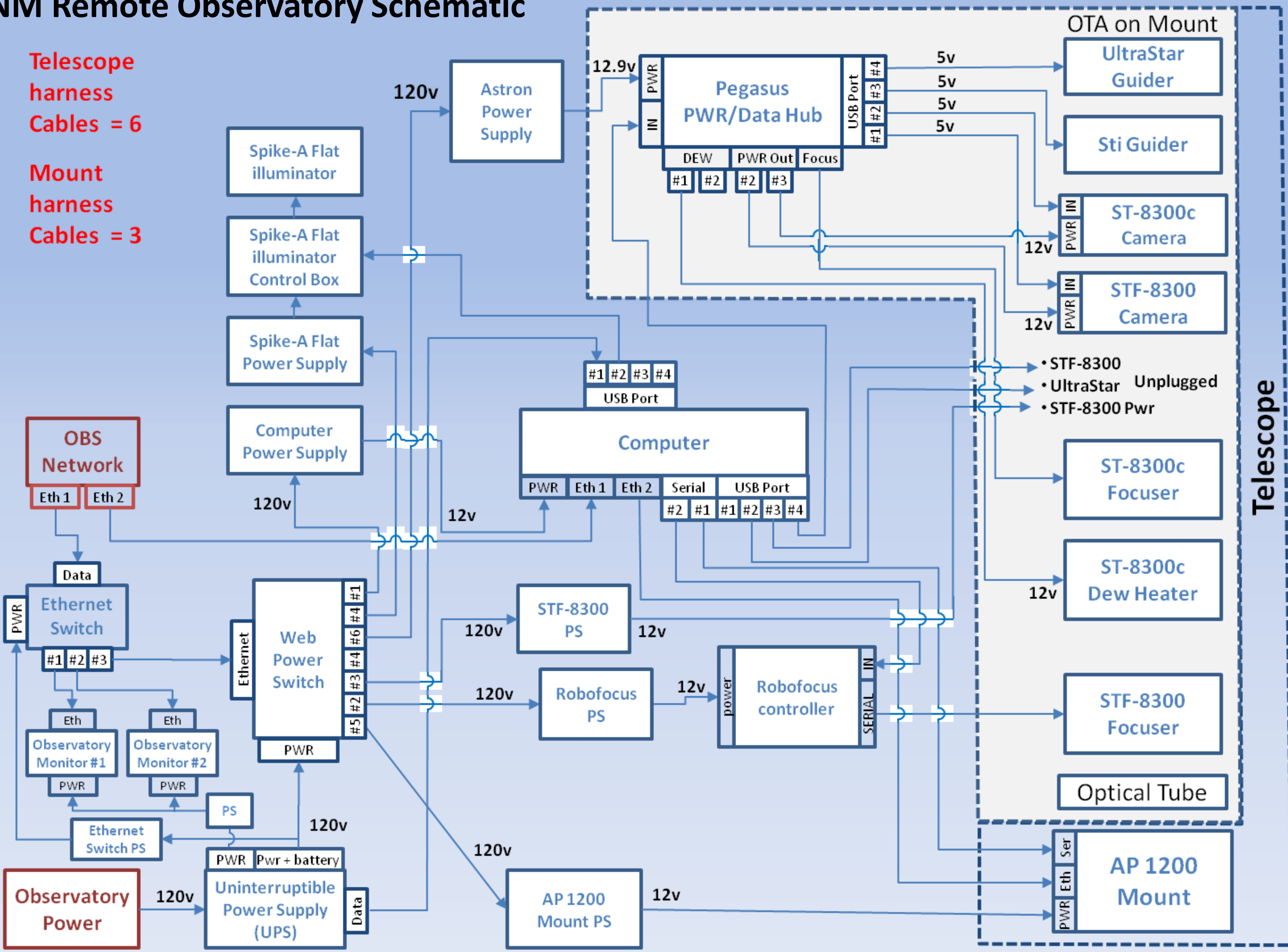
My Remote Telescope Documentation

NM Observatory Detailed Cable Configuration

				Cable						Min	
No.	From	Connector	Type	From	Length	To	To	Connector	In harness to OTA	Cable	
1	Observatory	3 Prong female	PWR	3 Prong male	6'	None	UPS	None	Cabinet		
2	UPS (Battery)	3 Prong female	PWR	3 Prong male	5'	None	DL Webswitch	None	Cabinet		
3	DL WebSwitch 1	3 Prong female	PWR	2 Prong male	10' PS	DC male	PC	DC female	Cabinet		
4	DL WebSwitch 2	3 Prong female	PWR	2 Prong male		DC male	Robofocus PS	DC female	Cabinet		
5	DL WebSwitch 3	3 Prong female	PWR	3 Prong male	3-6'	3 Prong female	SBIG STF-8300 PS	3 Prong male	Cabinet		Backup
6			PWR	---	5'	Locking DC 2.1 mm male	---		harness		Backup
7			PWR	Locking DC 2.1 mm female	11'	Locking DC 2.1 mm male	SBIG STF-8300	Locking DC 2.1 mm	harness		Backup
8	DL WebSwitch 4	3 Prong female	PWR	3 Prong male	1'	3 Prong female	---	---	Cabinet		
9			PWR	2 Prong male	---	---	Spike-A AC/DC PS	---	Cabinet		
10			PWR		3-6'	DC 2.1 mm male	Spike-A Controller	DC 2.1 mm female	Cabinet		
11	Spike-A Controller	DC male	PWR	DC female	6'	---	Spike-A Light Panel	---	Cabinet/Floor		
12	DL WebSwitch 5	3 Prong female	PWR	3 Prong male	3-6'	---	Radio Shack PS	---	Cabinet		
13	Radio Shack PS	cigerette lighter female	PWR	cigerette lighter male	1.5'	Powepoles female					
14			PWR	Powepoles male	8'	2 Prong female	AP-1200 Mount	2 Prong male	Cabinet/Pier by Pier harness		
15	DL WebSwitch 6	3 Prong female	PWR	3 Prong male	3-6'	3 Prong female	Astron PS	3 Prong male	Cabinet		
16	Astron PS	2 posts	PWR	1/4" rings	6'	Powepoles female			Cabinet/Pierby OTA harness		Primary
17			PWR	Powepoles male	1.5'	cigerette lighter female					Primary
18			PWR	cigerette lighter male	6'	2.5 mm DC male	Pegasus	2.5 mm DC female			Primary
19	Pegasus	Locking 2.1 mm DC female	PWR	Locking DC 2.1 mm male	25"	Locking DC 2.1 mm male	SBIG STF-8300	Locking DC 2.1 mm female	OTA		Primary
20	Pegasus	Locking 2.1 mm DC female	PWR	Locking DC 2.1 mm male	26"	Locking DC 2.1 mm male	SBIG ST-8300C	Locking DC 2.1 mm female	OTA		Primary
21	Pegasus	RCA female	PWR	RCA Plug male	6'	None	ST-8300C dew heater	None	OTA		Primary
22	UPS (Observatory)	3 Prong female	PWR	2 Prong male	---	---	AC/DC PS	USB A female	Cabinet		
23			PWR	USB 2 A male	1'	USB 2 Mini B male	Observatory Monitor 1	USB 2 Mini B female	Cabinet		
24			PWR	USB 2 A male	1'	USB 2 Mini B male	Observatory Monitor 2	USB 2 Mini B female	Cabinet		
25	Observatory	Ethernet female	DATA	Ethernet male	3' or 5'	Ethernet male	PC (rear)	Ethernet female	Cabinet		
26	PC (rear)	Serial DB9 male	DATA	Serial DB9 female	10'	RJ45 male	Robofocus	RJ45 female	Cabinet	2'	
27	RoboFocus	Serial DB9 male	PWR/DATA	Serial DB9 female	15'	Serial DB9 male	Moonlite Focuser-STF-8300	Serial DB9 female	Cabinet/Pierby OTA harness		
28	PC (rear)	Serial DB9 male	DATA	Serial DB9 female	6'	RJ45 male	AP-1200 Mount	RJ45 female	Cabinet/Pier by Pier harness		
29	PC (rear)	Ethernet female	DATA	Ethernet male	7'	Ethernet male	AP-1200 Mount	Ethernet female	Cabinet/Pier by Pier harness		
30	PC (rear)	USB 2 A female	DATA	USB 2 A male	15'	USB 2 B male	SBIG STF-8300	USB 2 B female	Cabinet/Pier by OTA harness		Backup
31	PC (rear)	USB 3 A female	PWR/DATA	USB 2 A male	15'	USB 2 B male	Ultrastar	USB 2 Mini B female	Cabinet/Pierby OTA harness		Backup
32	PC (rear)	USB 3 A female	PWR/DATA	Serial DB9 female	7.5"	USB 2 to RS-232 DB-9 Adapter					
33				USB 2 to RS-232 DB-9 Adapter	---	Powered RS-232 DB-9 Adapter					
34				Powered RS-232 DB-9 Adapter	15'	---	Inclinometer	None	Cabinet/Pierby OTA harness		
35				Powered RS-232 DB-9 Adapter	around 6'	5v PS					
36	PC (rear)	USB 2 A female	DATA	USB 2 A male	15'	USB 2 A male	Pegasus	USB 2 B female	Cabinet/Pierby OTA harness		
37	Pegasus	USB 2 A female	DATA	USB 2 A male	18"	USB 2 B male	SBIG STF-8300	USB 2 B female	OTA		Primary
38	Pegasus	USB 2 A female	PWR/DATA	USB 2 A male	18"	USB 2 Mini B male	Ultrastar	USB 2 Mini B female	OTA		Primary
39	Pegasus	USB 2 A female	DATA	USB 2 A male	18"	USB 2 B male	SBIG ST-8300C	USB 2 B female	OTA		Primary
40	Pegasus	USB 2 A female	PWR/DATA	USB 2 A male	18"	USB 2 Mini B male	SBIG Sti	USB 2 Mini B female	OTA		Primary
41	Pegasus	RJ45 female	PWR/DATA	RJ45 male	5'	Serial DB9 female	Moonlite Focuser on ST-8300C	Serial DB9 male	OTA		Primary
42	Pegasus	RCA female	PWR/DATA	RCA Plug male	28"	None	Pegasus Env sensor	None	OTA		Primary
43	PC (front)	USB 2 A female	DATA	USB 2 A male	6'	USB 2 A male	Spike-A Controller	USB 2 B female	Cabinet		
44	Observatory	Ethernet female	DATA	Ethernet male	3' or 5'	Ethernet male	ethernet switch	Ethernet female	Cabinet		
45	Ethernet Switch	Ethernet female	DATA	Ethernet male		Ethernet male	DL WebSwitch	Ethernet female	Cabinet		
46	Ethernet Switch	Ethernet female	DATA	Ethernet male		Ethernet male	Observatory Monitor 1	Ethernet female	Cabinet		
47	Ethernet Switch	Ethernet female	DATA	Ethernet male		Ethernet male	Observatory Monitor 2	Ethernet female	Cabinet		
48	UPS	USB 2 A female	DATA	USB 2 A male	3 or 4'	USB 2 A male	PC (front)	USB 2 A female	Cabinet		
				measured - Green							

My Remote Telescope Documentation (continued)

NM Remote Observatory Schematic



Shuttle PC Cable Connection Configuration

Front

USB 3
Spare

USB 2
Spike-A

USB 3
Spare

USB 2
UPS

Rear

Serial #1
Mount

Serial #2
RoboFocus

PWR

Ethernet
Network

Ethernet
Mount

USB 3
Ultrastar

USB 2
STF-8300

USB 3
Spare

USB 2
Pegasus

Pegasus Data/Power Hub

<u>12v Outputs</u>

1) None
2) STF-8300
3) ST-8300C
4) None

<u>Dew Heaters</u>

A)
B)

<u>12v DC In</u>

PC	USB 2 ST-8300c	USB 2 STi	USB 2 None	Sensor	Focus ST-8300c
	USB 2 STF-8300	USB 2 UltraStar	USB 2 None		

Ethernet Switch

Ethernet

1) Observatory Monitor 111
2) Observatory Monitor 112
3) Web Switch
4) None
5) Network In

Datalogger's Web Power Switch

AC Power

1) Shuttle PC
2) RoboFocus PS
3) STF-8300 PS (backup)
4) Spike-A
5) Radio Shack PS
6) Astron PS
7) None
8) None

Astro-Physics CP4

<u>CP4 Connectors</u>

- Top RS-232 to PC (Com 1 in APCC)
- Ethernet to PC
- Motors to RA & DEC motors
- 12v DC from Radio Shack PS

Not Used

- USB
- Bottom RS-232
- AUX
- AUTOGUIDER
- ENCODER
- KEYPAD

No.	Telescope Inventory Name
1	TPO 12" RC Telescope
2	AP 1200 RA Axis in Box
3	AP 1200 base in Box
4	Rotating Pier Adapter w flat plate
5	Mount Telecope dovetail w six 1/4-20 cap head bolts
6	AP 1200 Counter weight shaft in mount box
7	AP 1200 Counter weight shaft end Cap in small part tray
8	(1) 30 lb counterweight
9	(3) 18 lb counterweights
10	(1) 10 lb counterweight
11	STF-8300 w filter wheel on Moonlite focuser
12	WO81 on Moonlite focuser, ST-8300, with rings
13	Telescope Harness with 6 cables and STF-8300 PS
14	Mount Harness with 3 cables
15	Pegasus with cables
16	Equipment cabinet with shuttle computer w PS, UPS, radio Shack PS, Astron PS, web power switch, ethernet switch with PS, Robofocus controller w PS, Spike-A controller w PS, Observatory Moniters (2) w PS
17	Dew heater strap w cable
18	AstroZap Dew Shroud w ring + velco straps + connector bolts(in small parts tray)
19	Cabinet Shelf

No.	Auxiliary Equipment
1	Dell i7 Computer with power supply and mouse + key drive
2	laser collimator w inserts (2) and compression ring 68mm to 2"
3	Collimination White Board
4	SBIG STF-8300 desiccant plug in small parts tray
5	one pound counter weights (5)
6	Electrical Connection Plug/covers (USB, RJ-11, etc)
7	Cloth light Shroud
8	Right angle polar alignment scope
9	box of ethernet 3' cables
10	box of ethernet 5' cables
11	10' ethernet cables (2)
12	10' serial to serial cable
13	head lamp with extra batteries

No.	Tools/supplies
1	Portable Ramp
2	Portable Table
3	Metric and Imperial Allen wretches, Stubby allen wretches in tool bag
4	Long T-handle Allen wretch 3/16" in tool bag
5	Electric Drill and bits in tool bag
6	Multi-Meter with leads in tool bag
7	small part tray w telescope wretches, pegasus bolt, levels
8	3' extension cord (2)
9	8" extension cord (2)
10	Wire cutters and crimper in tool bag
11	Tool Box
12	Tool Bag
13	Velco (long/medium cable wraps, band, two sided), duct tape

The End