

# Astronomical Adventures

My Journey of Building, Outfitting and Operating  
a Remote Observatory... So Far

Milky Way and Meteor  
From Observatory Hill  
Mariposa, Ca.

Manny Leinz  
The Astro Imaging Channel  
July 5, 2020



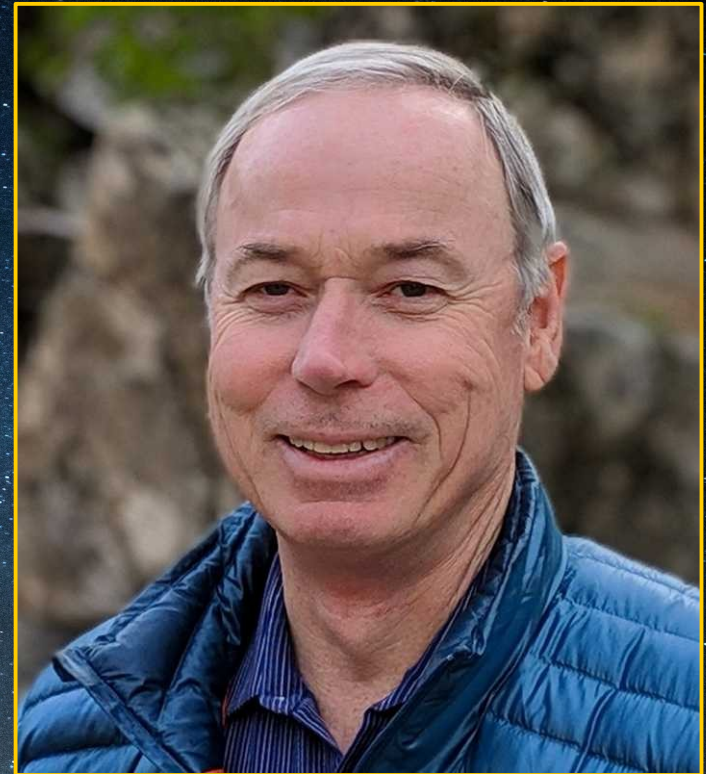
# We Will Talk About...

- Dreaming to building – Selecting the Observatory Site
- From Usable to Functional - Initial outfitting
- Autonomy by Baby Steps – A Phased Approach
- Thermal Considerations – To Insulate or Not?
- Challenges...
- Pausing for an Upgrade - New Scope and Mount
- Next Steps



# A Little About Me...

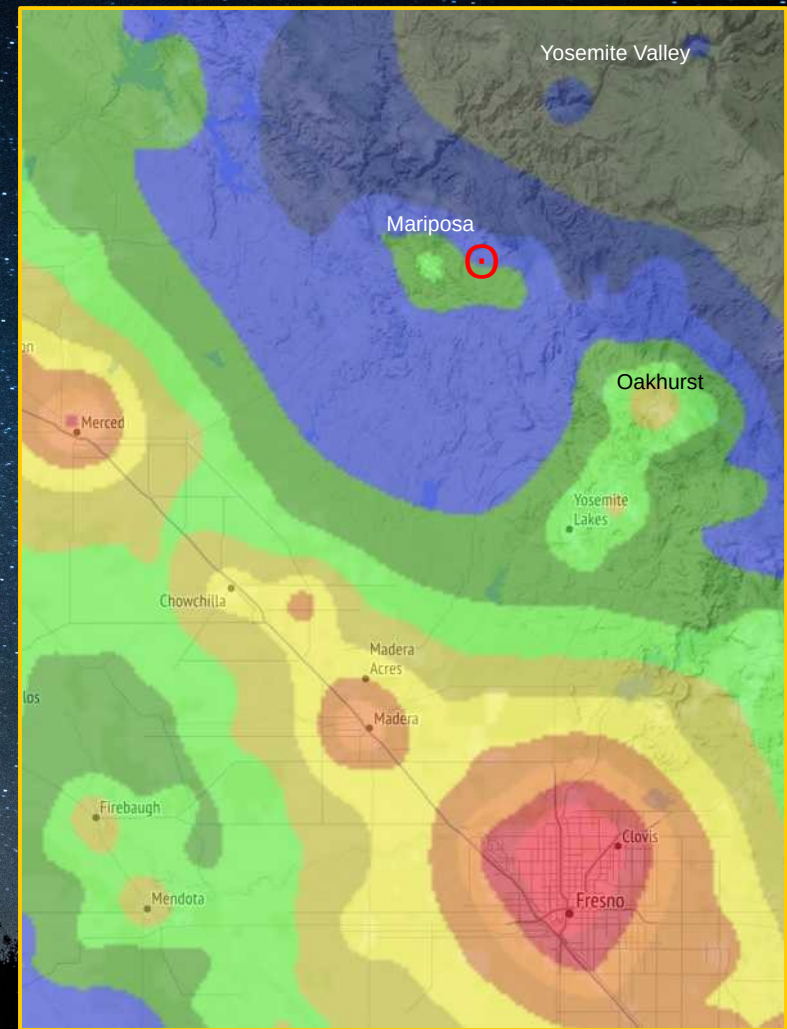
- Happily married husband and father
- Former Engineering Manager in Boeing Space business
  - Retired 2015
- Amateur astronomer for 30+ years
  - Observational and more recently astrophotography
  - RAS Member for several years
  - Dreamed of having an observatory for many years
- Enjoy travel, photography (including nightscapes), guitar, family history





# Dreaming to Building - Selecting the Site

- **Objective:** Build an observatory far from city lights on the site that would double as a vacation home in the mountains
  - Visual Astronomy
  - Astroimaging
  - Electronically Assisted Astronomy – Outreach
  - Citizen Science
- We selected a property outside the Gold Rush town of Mariposa (Bortle class 3) – Purchased December 2014
- Pros:
  - Reasonably dark location
  - Comfortable sleeping arrangements on site – no warm room needed
  - Our favorite National Park nearby!
- Cons:
  - Long drive (No dark sites in the local mountains)
  - Autonomous systems need to be very robust
  - Not the cheapest option...



[darksitefinder.com/maps](http://darksitefinder.com/maps)



# Observatory Design Details

- Roll-off roof design – Inconspicuous, simplified control
  - Roll-off to the east, toward house
  - Future pergola for aesthetics
- Size: 15' x 8' (120 ft<sup>2</sup>) – Avoids building permits
  - External “plug-in” power
- Accommodate two piers: Observational, Astroimaging
- Platform floor – Cheaper than concrete, simplifies cable runs underneath
- Contractor build
  - Backyard Observatories ([www.backyardobservatories.com](http://www.backyardobservatories.com))
  - Proven track record (ours is observatory #253)
  - Shortened time to first light



# Observatory Build

## Three Days in 60 Seconds...





# Road to First Light



*North Pier Installation*



*CGEM Adapter*



*CGEM-1100 Mounted and Ready*



# Places to Put My Stuff...



*Eyepiece Shelves With  
Dimmable LED Strip Lights*



*Scope and Computer Desk*



# Power and Processing



12Volt DC Power Bricks



<https://www.atm-workshop.com/win10-red-mode.html>

PC With Backlit Keyboard



# Initial Imaging Configuration

- Telescopes:
  - Celestron CGEM-1100
  - Stellarvue SV70ED 70 mm refractor
- Imaging Camera
  - Canon 60D DSLR, then...
  - ZWO ASI294 MC Pro (10.7 Mpixel Color Cooled)
- Guide Camera/Scope
  - QHY5L-II 1.2 Mpixel monocheme
  - Astromania 60 mm Scope





# Autonomy Phases

	Phase 1	Phase 2a	Phase 2b	Phase 3a	Phase 3b
<b>Control Location</b>	Observatory	Mariposa Home	Mariposa Home	SoCal Home	SoCal Home
<b>Capabilities</b>	Local Manual Startup/Shutdown And Operation	Manual Startup/Shutdown <u>Tele-Operation Imaging</u>	<u>TeleOp</u> Startup/Shutdown Remote Autonomous Imaging	<u>TeleOp</u> Startup/Shutdown Remote Autonomous Imaging	Full Remote Autonomy
<b>Power</b>					
Input	115VAC Line	115VAC Line	115VAC Line	115VAC Line	115VAC Line
Subsystems	DC power bricks	DC power bricks – <u>wifi smart socket controlled</u>	DC power bricks – <u>wifi smart socket controlled</u>	DC power bricks – web power switch controlled	DC power bricks – web power switch controlled
Battery Backup – Auto Roof, Park Mount	None	None	None	Yes-Implementation <u>TBD</u>	Yes-Implementation <u>TBD</u>
<b>Internet</b>					
	None – File transfer via “sneakernet”	1000 Base T Ethernet with <u>Wifi Hotspot</u>	1000 Base T Ethernet with <u>Wifi Hotspot</u>	1000 Base T Ethernet with <u>Wifi Hotspot</u> 4G Cellular backup	1000 Base T Ethernet with <u>Wifi Hotspot</u> 4G Cellular backup
<b>Mount</b>					
	<u>CGEM-1100</u>	<u>CGEM-1100</u>	CEM120-EC2	CEM120-EC2	CEM120-EC2
<b>Imaging Scope</b>					
	<u>Celestron 11”</u>	<u>Celestron 11”</u>	<u>Celestron RASA 11</u>	<u>Celestron RASA 11</u>	<u>Celestron RASA 11</u>
<b>Focus</b>					
	Manual <u>Bahtinov Mask</u>	Manual <u>Bahtinov Mask</u>	<u>Celestron Motor Focuser</u> <u>TBD - Software Automated</u>	<u>Celestron Motor Focuser</u> <u>TBD - Software Automated</u>	<u>Celestron Motor Focuser</u> <u>TBD - Software Automated</u>
<b>Guiding</b>					
Scope	<u>Astromania 60 mm</u>	<u>Astromania 60 mm</u>	<u>Astromania 60 mm</u>	<u>Astromania 60 mm</u>	<u>Astromania 60 mm</u>
Camera	<u>QHY5L-II</u>	<u>QHY5L-II</u>	<u>QHY5L-II</u>	<u>QHY5L-II</u>	<u>QHY5L-II</u>



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<b>Roof Control</b>					
	Electric motor via hand controller	Electric motor via hand controller	Electric Motor via Ethernet Control	Electric Motor via Ethernet Control	Electric Motor via Ethernet Control
					Autonomous Closing on Rain
					Autonomous Obstruction Sensing
				Battery Backup	Battery Backup
<b>Lighting</b>					
	Red, white with wall switch control	Red, white with wall switch control	Red, white with Ethernet control	Red, white with Ethernet control	Red, white with Ethernet control
<b>Situational Awareness</b>					
	None	None	Two 5 MP <u>PoE Reolink</u> Cameras	Two 5 MP <u>PoE Reolink</u> Cameras	Two 5 MP <u>PoE Reolink</u> Cameras
					Roof Clearance Detector (Implementation TBD)
<b>Weather</b>					
Indoor/Outdoor Temperature, Wind, Rain, Barometric Pressure	None	Ambient Weather <u>WS-0900</u>	Ambient Weather <u>WS-0900</u>	Ambient Weather <u>WS-0900</u>	Ambient Weather <u>WS-0900</u>
All Sky Cloud Sensor	None	None	None	<u>TBD</u>	<u>TBD</u>
Rain Sensor	None	None	None	<u>TBD</u>	<u>TBD</u>
					Command Roof Closure on Rain
<b>Software</b>					
Interface	<u>ASCOM</u>	<u>ASCOM</u>	<u>ASCOM</u>	<u>ASCOM</u>	<u>ASCOM</u>
Remote Control	None	<u>Teamviewer</u>	<u>Teamviewer</u>	<u>Teamviewer</u>	<u>Teamviewer</u>
Planetarium	<u>Stellarium</u>	<u>Stellarium</u>	<u>TBD</u>	<u>TBD</u>	<u>TBD</u>
Guiding	<u>PHD2</u>	<u>PHD2</u>	<u>PHD2</u>	<u>PHD2</u>	<u>PHD2</u>
Image Acquisition	<u>Nebulosity</u>	<u>Nebulosity</u>	Sequence Generator Pro, NINA?	Sequence Generator Pro, NINA?	Sequence Generator Pro, NINA?
Plate Solving	None	None	<u>TBD</u>	<u>TBD</u>	<u>TBD</u>

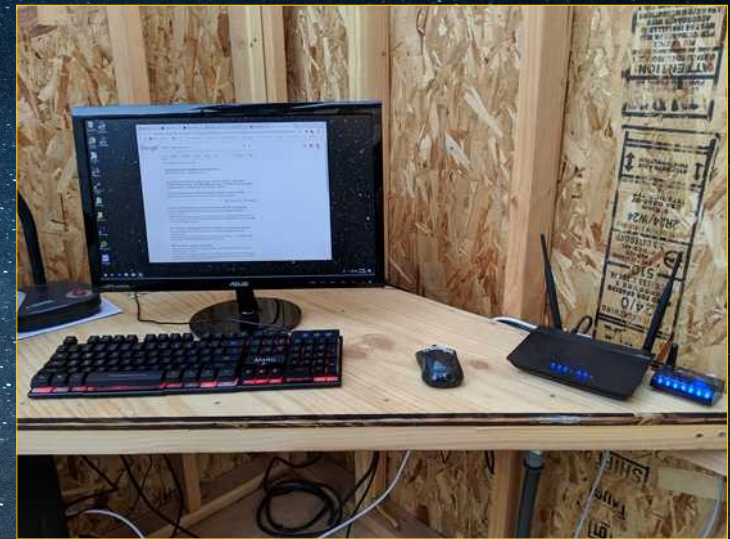


# Autonomy By Baby Steps

- Phase 2a: And there was Internet...



*Friends With Backhoes are Indispensable!*



*Ethernet Switch with Wi-fi*



# Weather



Ambient Weather WS-0900



Wireless Receiver / Access Point

**Station Summary**  
● Online (updated 6 seconds ago)

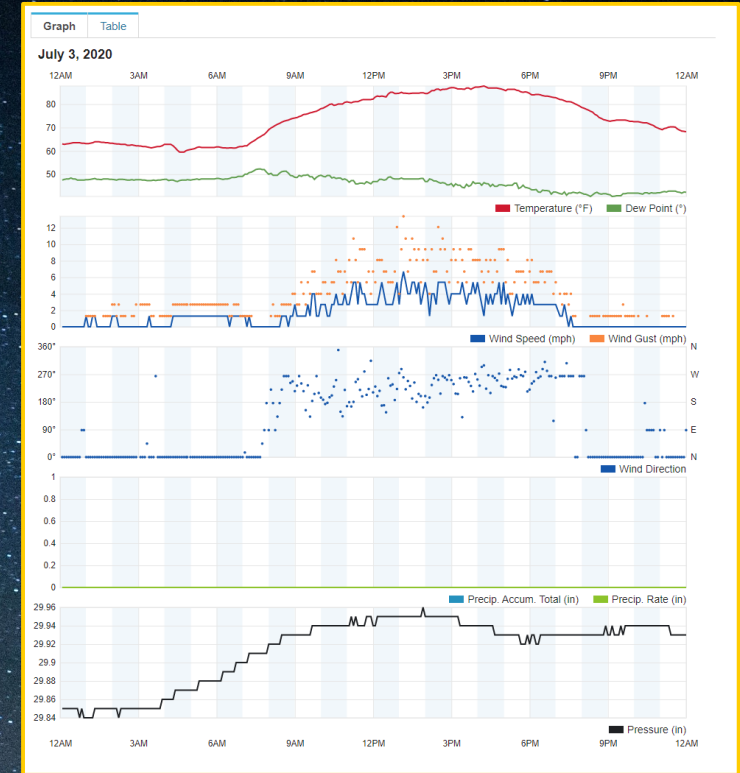
**CURRENT CONDITIONS**

<b>66.6</b> ° F Feels Like 66.6 °	<b>WIND &amp; GUST</b> 0.0 / 0.0 mph
<b>DEWPOINT</b> 41.5 ° F	<b>PRECIP RATE</b> 0.00 in/hr
<b>HUMIDITY</b> 40 %	<b>PRECIP ACCUM</b> 0.00 in
<b>PRECIP RATE</b> 0.00 in/hr	<b>PRECIP TOTAL</b> 0.00 in

**MAP**  
Darrah, Ellenton Co, VA  
View WunderMap

**PWS CURRENT CONDITIONS**

<b>TEMPERATURE</b> CURRENT 67° DEWPOINT 41.5 ° F HUMIDITY 40 %	<b>WIND</b> 0.0 WIND FROM N GUST 0.0 mph	<b>PRESSURE</b> CURRENT 29.93 in
<b>PRECIPITATION</b> PRECIP RATE 0.00 in/hr PRECIP TOTAL 0.00 in	<b>UV</b> UNAVAILABLE	



Weather Underground App



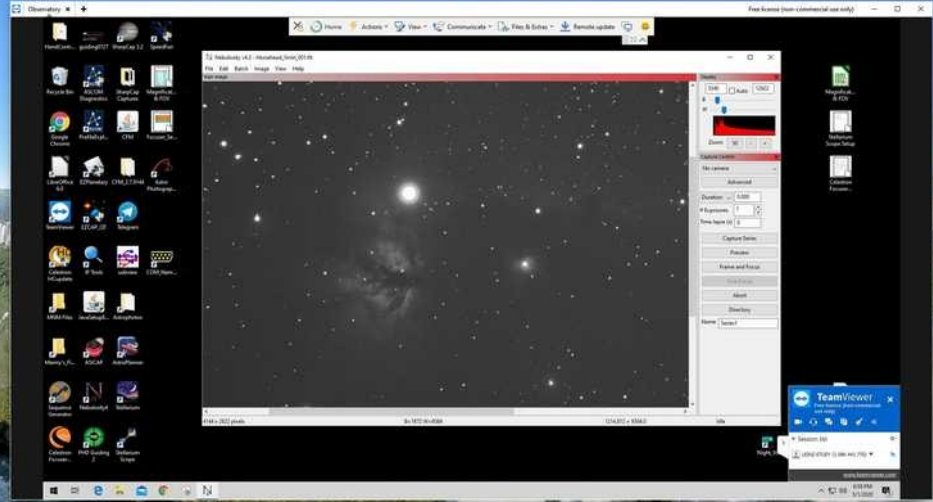
# Remote Control



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- Works with Alexa Google Home
- Remote Control by App
- Timer Function
- 2 IN 1 Compact Size
- Individual/Dual Control
- Group control
- Family Share
- No-hub Required

*Wifi Smart Outlets*

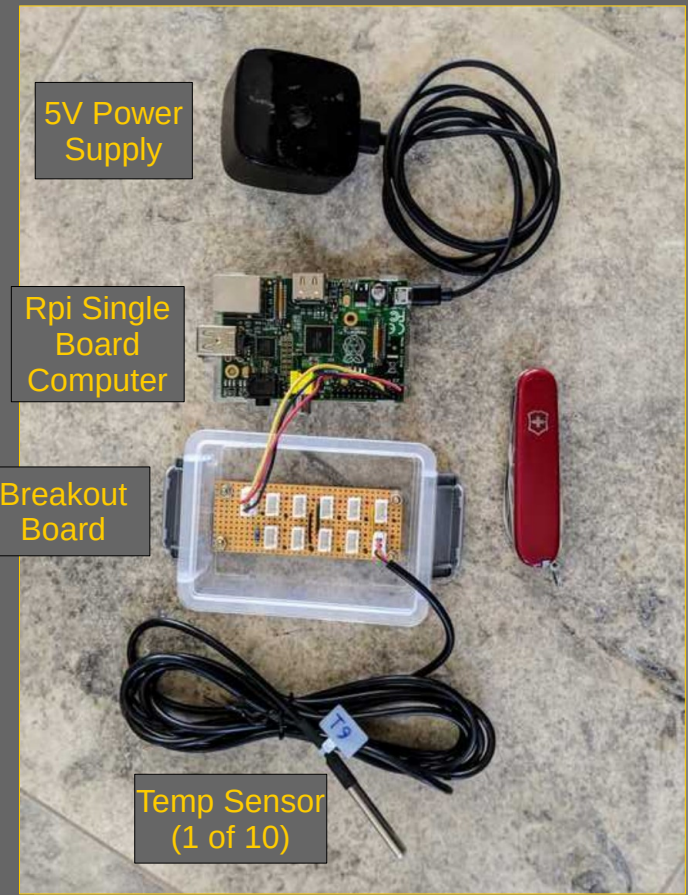
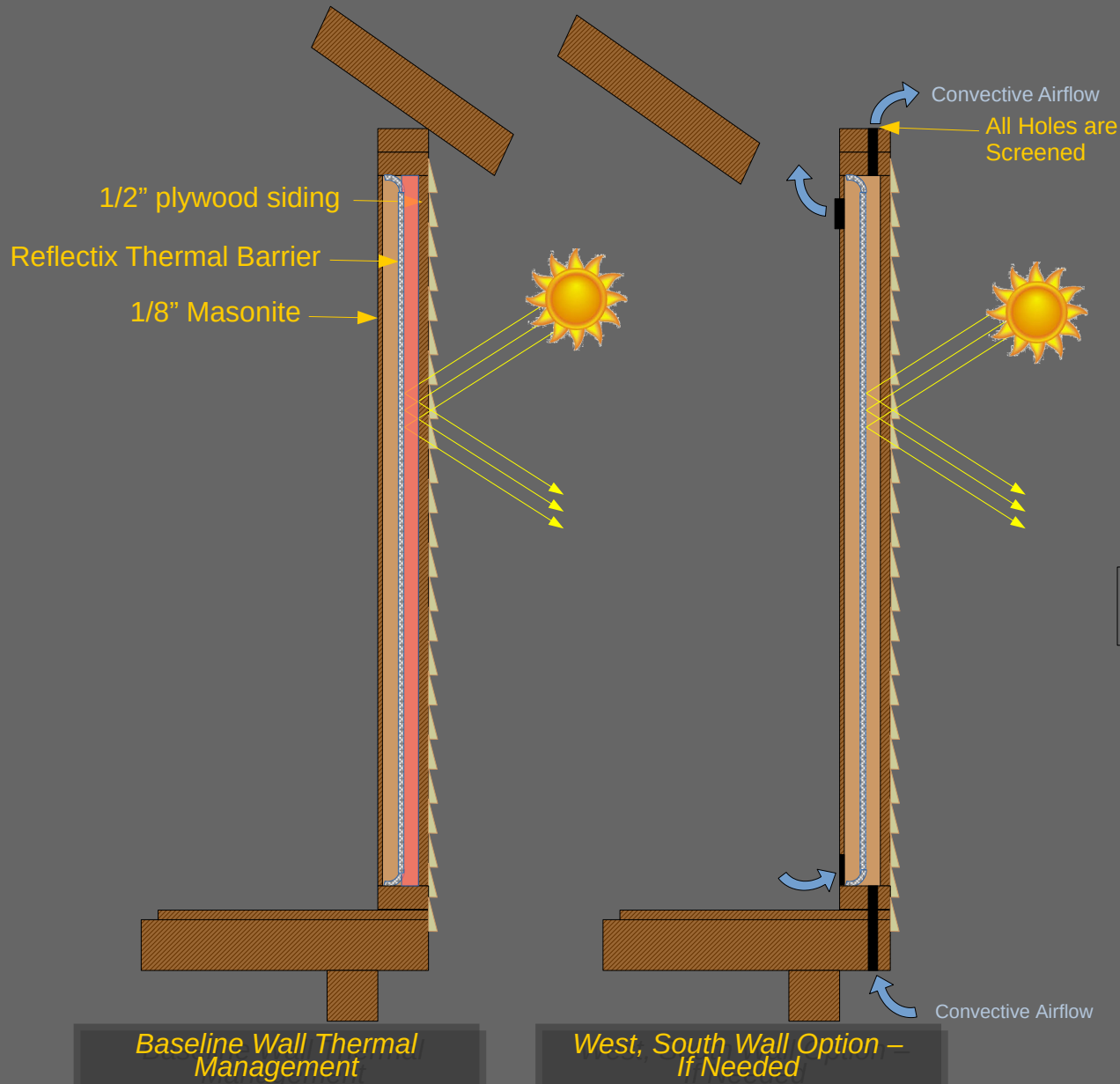


www.teamviewer.com

*Teamviewer App*



# Thermal Considerations



Raspberry Pi Temperature Data Logger



# Challenges - Critters





# Challenges - Dew





# Challenges – Plan Ahead





# Pausing for an Upgrade



- Celestron RASA-11
- Ioptron CEM120 EC2



# Next Steps

- Complete Observatory Interior
  - Wallboard, cabinets, flooring, paint
- Implement remote roof closure (Phase 2b)
  - DIY Raspberry Pi Solution, or
  - Off the shelf commercial with integrated Weather monitoring
- Ethernet Power Control
  - Replace wifi Smart outlets





*The Crescent Nebula (NGC6888), Image captured June 24, 2020 from Mariposa, Ca. Celestron RASA-11 scope on an Ioptron CEM120-EC2 mount, 40 two minute exposures, unguided. Processed in Deep Sky Stacker and Photoshop.*