Equatorial Tracker Workshop

For The Los Gatos / Saratoga Camera Club

Rick Whitacre © 2022

www.whitacrephotography.net

Housekeeping

- This Zoom session will be recorded and I will send out a PDF of this presentation after the call. Links for many things in this presentation are within the slides and at the end. No need to take notes
- You will be muted during the presentation, so please save your questions for the Q&A session at the end
- Someone will monitor the chat session in case any technical problems come up
- After the presentation, I will go through how I setup, balance, and polar align my tracker. Please stick around if you have time!
- Now, without further ado……

What is an EQ Tracker?

- An Equatorial (EQ) Tracker is a motorized mount that rotates on the same axis as the Earth, but in the opposite direction
- When properly aligned, it counteracts the rotation of the Earth to keep the camera lens or telescope pointed at the same celestial body (moon, sun, planets, stars, nebula, etc) for long periods. The motor has different speeds for stars, moon and sun.
- Astronomers and Astrophotographers have been using them for almost 2 centuries. Until recently, they tended to be large, heavy, and difficult to set up. Now, several units have come on the market to meet the needs of Astro-Landscape Photographers

Why Use an EQ Tracker?

- An Equatorial Tracker allows for longer exposures with no apparent motion (or rotation) of the celestial body in the camera frame
- With a fixed tripod, photographers are limited to the “500 rule” (or similar) to avoid star streaks in their image. This is very difficult at focal lengths >= 70mm. (100mm lens is limited to 4-5s exposure on fixed tripod!)
- EQ trackers allow for much longer exposures. Two of the trackers we will look at can do 1-4 minute exposures at 100-200mm (12 - 48X longer!)
- Longer exposures allow for lower ISO settings, more Dynamic Range (DR), and better Signal to Noise Ratios (SNR), i.e., Higher Image Quality (IQ) and more detail
- Trackers improve images on Wide Field (Milky Way, Orion Nebula, etc), DeepScapes (Andromeda, Pleiades, Comets, etc) and Eclipses (Solar and Lunar)

Tracking Comparison

100mm, 6s, ISO25600, Motor Off

100mm, 50s, ISO1600, Motor On

Examples

Veils of the Seven Sisters

Examples

Andromeda Rising over Mount Shasta

Examples

Scorpion Set

Examples

Comet Neowise

Time-lapse of Tracked Image

Link to Video

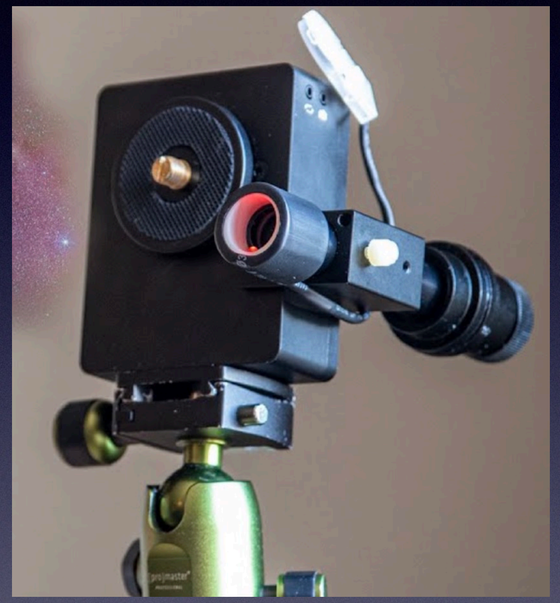
Examples

Perseid Meteors over Bristlecone Pine

Review of the Peter Zelinka Video

- The 3 most popular EQ Trackers for Astro-Landscape photographers are the Move-Shoot-Move Rotator (MSM), iOptron SkyGuider Pro, and the Sky-Watcher Star Adventurer (SWSA)
- Each has their own pros and cons as the video covered
- I generally agree with Peter, but disagree on some critical points, which I will will cover as we go through them
- They are all good options, but have some key differences

Popular Low-cost EQ Trackers



Move-Shoot-Move
Rotator

iOptron
SkyGuider Pro

Sky-Watcher
Star Adventurer

Move-Shoot-Move (MSM)

- This is the smallest, lightest, and least expensive of the three
- If you do a lot of backpacking or hiking where size and weight are paramount, then this is a good option
- It also has the smallest payload and the polar alignment options are not as precise. It is the least stable of the 3 options
- It *might* be a good starter option, but a photographer I know has found it too limiting and is upgrading to one of the other options
- The full kit is a little less than $400

iOptron SkyGuider Pro

- The SkyGuider Pro is a stable platform capable of camera and lenses up to about 400-500mm (with optional counter-weight)
- Built in polar scope and illuminator
- Optional Dec bracket and counter-weight
- The full kit includes the equatorial wedge, Dec bracket, and counter-weight. I recommend getting all of them as a kit
- Full kit is about $550 ($488 promotions are common)

Sky-Watcher Star Adventurer

- The SWSA is a stable platform capable of camera and lenses up to about 400-500mm (with optional counter-weight)
- Built in polar scope and detachable illuminator
- Optional Dec bracket and counter-weight
- The full kit includes the equatorial wedge, Dec bracket, and counter-weight. I recommend getting all of them as a kit (Pro Pack)
- Full kit is about $450

Differences in Tracker Options

- MSM has a very limited load capability, but is much more portable than the other two. iOptron is smaller than SWSA
- iOptron has a built in polar scope illuminator, which can be nice
- SWSA has a fine-adjust knob on the Dec Bracket which is very handy for longer lenses
- Both iOptron and SWSA need the Dec bracket to be able to use the polar scope during imaging. Attaching a ball head directly to the tracker blocks the scope

Differences in Tracker Options (cont)

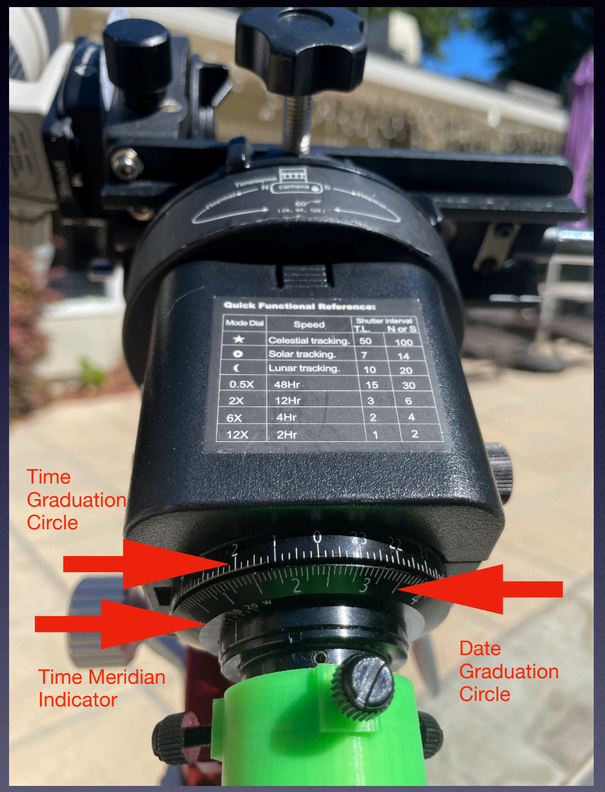
- Both iOptron and SWSA have relatively poor equatorial wedges. I chose to upgrade mine
- SWSA has a flimsy battery cover and rotary dial. iOptron is more “bullet-proof”
- SWSA uses 4 AA batteries, iOptron has rechargeable internal batts. Both can use external power
- None of these trackers have a motor on the Dec axis. This means that none of the trackers are true “GoTo” trackers

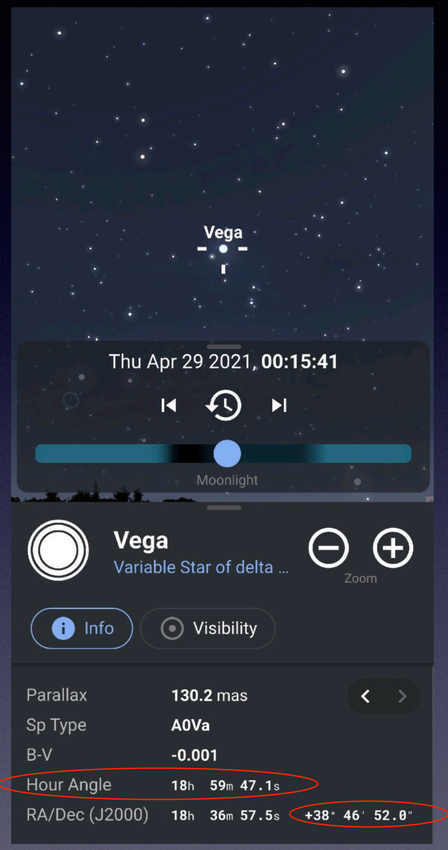
One ***Key*** Difference (iOptron to SWSA)

- The SW Star Adventurer has a time/date scale on the RA axis which means you can rotate your tracker to the Local Hour Angle (LHA) of any object. This value is provided by Stellarium+ and others on a smartphone
- By adding an optional Dec scale and calibrating it, you can also “dial in” the Dec value provided by Stellarium+
- These two scales provide a way to manually “GoTo” any celestial body!
- While not a reason to switch to SWSA if you already have an iOptron, it is something to consider if initially choosing between the two options

RA and Dec Scales on SWSA

Provide for a Manual “GoTo”





SWSA RA Scale
For Local Hour Angle

Optional Dec Scale
Calibrated to NCP

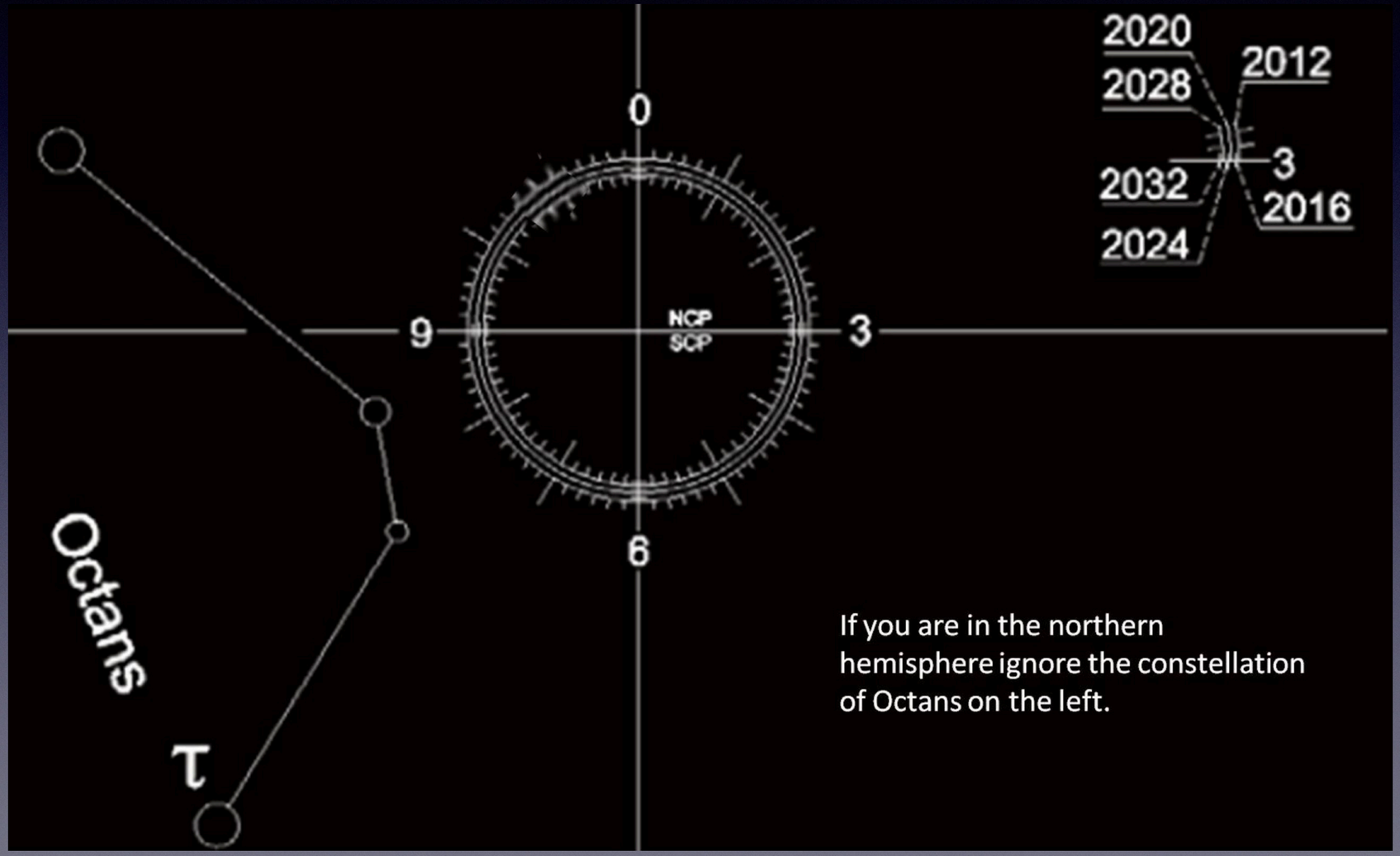
Stellarium+ provides Local Hour Angle and Dec Angle

Polar Alignment (PA)

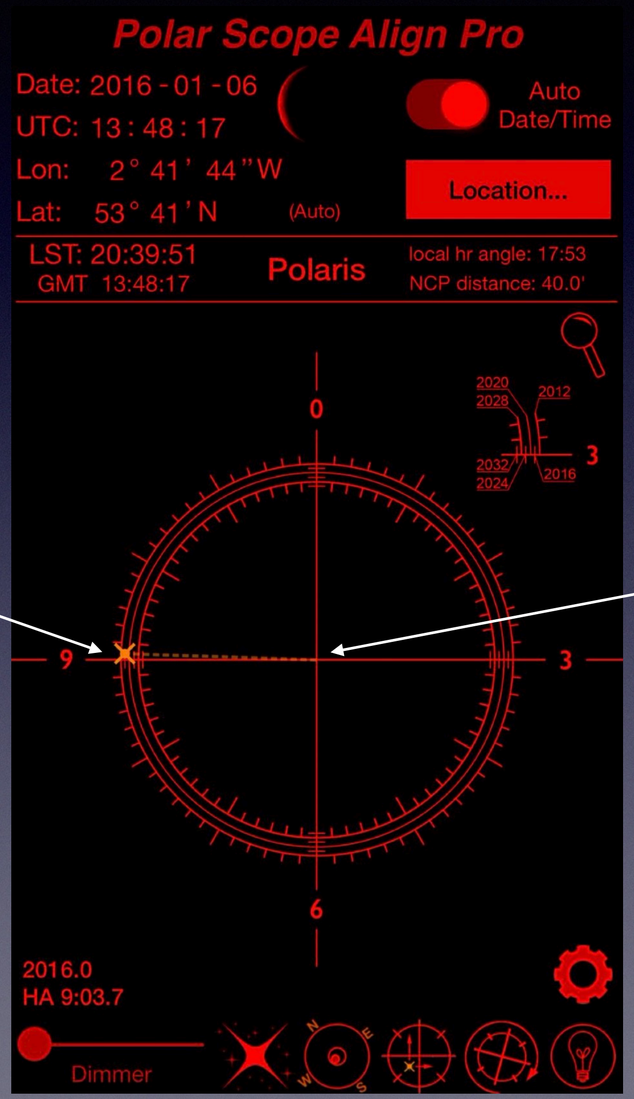
- Polar Alignment is the alignment of the axis of rotation of the tracker with the axis of rotation of the Earth (aligning to the North Celestial Pole here)
- Accurate PA of your tracker is ***critical*** for good results
- The MSM has both a laser pointer (check local laws!) and a small polar scope option, while both the iOptron and SWSA have built-in, on-axis polar scopes
- While aligning the tracker to Polaris is good enough for short, wider angle shots, you need to align the tracker to the North Celestial Pole (NCP) for longer lenses and longer exposures. Polaris is 0.8° from the NCP
- The polar scopes have reticles etched into the glass to aid with PA

Polar Alignment

Polar Alignment Reticle (SWSA)



Polar Alignment App



Polaris

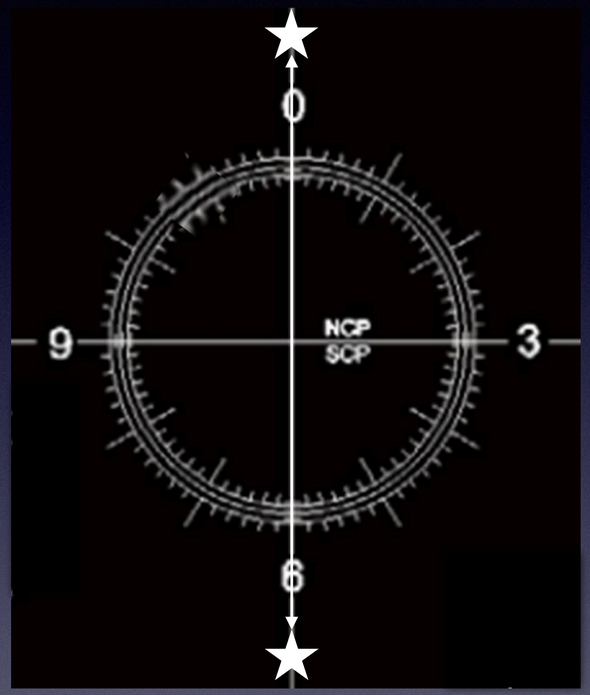
North Celestial Pole

Polar Alignment Basics

- Point the tracker as close to North as possible and level the tripod base
- Use an inclinometer to set the angle of the tracker to your local latitude. Your local latitude is always the same as the Altitude (Alt) of the NCP
- Balance your Tracker first in the Dec and then the RA axis
- When dark enough, find Polaris in the polar scope and align it onto the circle of the reticle to match the smartphone app. Make sure that the axis of the Polar Scope reticle is straight up and down (0-6 axis) before doing this (see next slide)
- Start the motor on your tracker
- Take a long test shot to insure good PA and to see how long your exposures can be without star streaking
- Re-check PA after any manual adjustments to the tracker (re-targeting, etc). It can be easy to lose PA. Using Dec bracket is key so that you can see through the polar scope

Reticle Rotation Alignment

(Important to get best Polar Alignment)



When aligned, a star on the 0-6 axis will stay there when Altitude is adjusted up and down

iOptron calibrated and marked where reticle is aligned

Rotate RA axis to Oct 31st on SWSA to align reticle (Meridian = 0)

Recommended Optional Upgrades
(Move-Shoot-Move Rotator)

- A “Z” Bracket provides better balance of the camera over the tracker

MSM Z Bracket

Recommended Optional Upgrades
(iOptron and Sky-Watcher Only)

- A Williams Optics equatorial wedge is a very good upgrade for any serious work. Makes PA easier and more stable (~$200)
- A right-angle viewer on the polar scope reduces strain on our poor bodies and has a magnifier for better PA (~$50)
- While all of these trackers mount to a standard tripod, I upgraded to a heavy duty tripod. I'm limited to a few dozen yards from my car, though, if I want to use it (~$175 and ~14 lbs!)

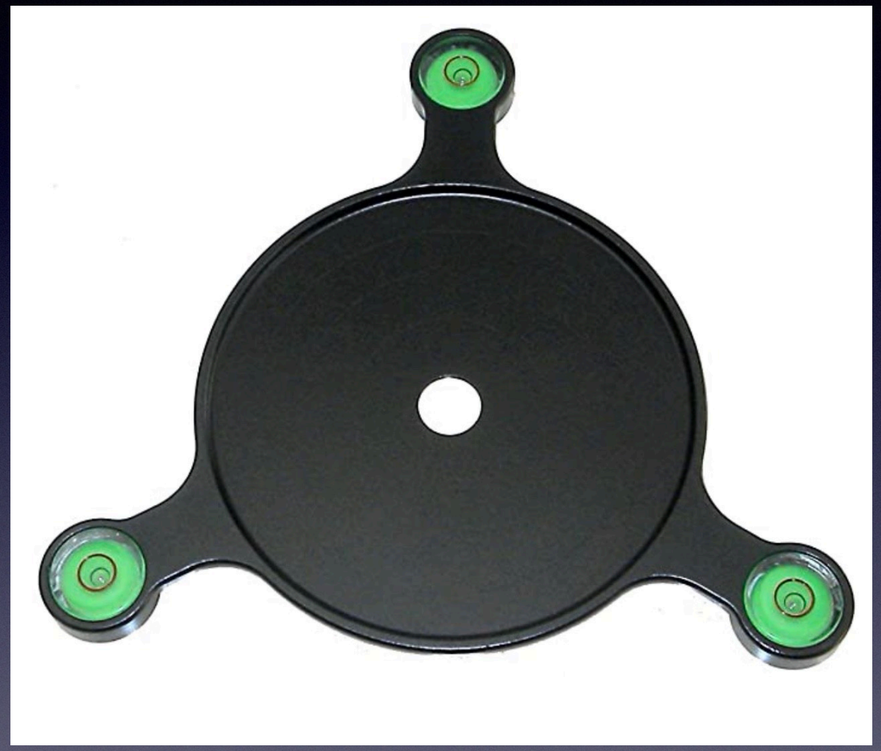
Recommended Options

Williams Optics Wedge

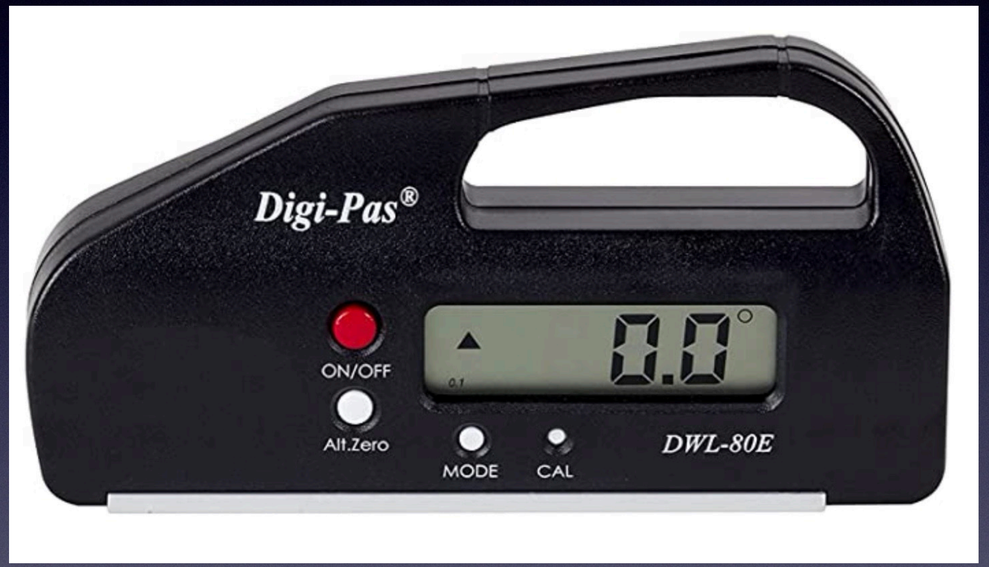
Right Angle Viewer

Heavy Duty Tripod

Helpful Accessories



Tripod Level
Indicator



Digital Level for
Adjusting Altitude
Of Wedge

Notes on Imaging

- Many lenses are better when stopped down a bit. Test your lenses by looking carefully at the shape and color of stars to find the optimum f/stop
- Back off maximum shutter duration a bit. Don’t push it to the edge of your polar alignment
- For the best images, try to take Calibration Frames every time you go out. Order of priority:
  - Lights: These are the actual images you are taking. 30-120+ minutes of total exposure time
  - Darks: Taken at EXACT same settings as Lights, but with lens cap on. Used to reduce noise and hot pixels. Same temperature is critical. Ideally, same total exposure time as Lights, but at least 20-30 minutes
  - Flats: Taken using Aperture Priority at same focal length and f/stop as Lights, but with a uniform light source. Used to correct vignetting and uneven light across the image. 50-100 images
  - Bias: Taken using Shutter Priority at 1/8000 at same ISO as Lights. Used to characterize read noise of sensor. 50-100 images
- These Calibration Frames can be combined in astro software such as Siril, Nebulosity, and PixInsight

Lessons Learned

- Getting proficient at using a tracker requires a LOT of time. Practice in your backyard until you are comfortable before going out on an important shoot
- Don’t beat your head against the wall trying to do more than your rig will do. Understand the limitations of your chosen tracker and how to mitigate them
- Rushing thru setup (leveling, balancing and PA) could ruin hours of imaging through improper alignment. Take your time. Endeavor to “nail” the PA every time
- Tighten EVERYTHING down at each step. This will help with imaging and prevent your camera/lens from falling off!
- Take test images and review at 100%. Confirm that stars are not streaking and in focus
- Take Calibration Frames every time. Darks and Flats are the only way to pull fine detail out

Q&A

Reference Material

Links

- Move Shoot Move, iOptron, Star Adventurer
- Williams Optics Wedge, Right-Angle Viewfinder, 3D-Printed Adaptor
- Sky-Watcher Steel Tripod, MSM Z Bracket
- 3D Printed Polar Scope Illuminator for SWSA
- Tripod Level Indicator, Digital Level, Polar Alignment App
- Handy Tutorials from Me!, Great Article
- Video on GoTo Mods for SWSA, Good Site for iOptron Tips
- Calibration Frames

Rick’s Setup Checklist

- Point wedge toward North
- Level Tripod
- Set Altitude on wedge with inclinometer
- Attach EQ Tracker
- Attach 2X eye piece
- Attach Dec Bracket
- Attach Counter Weight
- Attach Camera and Lens with cables
- Balance Dec axis first
- Balance RA axis (East-heavy)
- Rotate RA so scope reticle is straight up and down (0-6)
- Polar Align

But What About _____?

- Rainbow Astro RST-135: True EQ Mount, but $4000!
- Capsule 360: Panorama solution only. Not aligned to Earth axis
- Polaris - Electric Tripod Head: Pan-Tilt only. Not aligned to Earth axis
- Any “Alt-Az” Mount: Not aligned to Earth axis. Great for visual work, But not great for photography. Embedded processor tracks object, but does not correct for rotation over time
- If you want to do photography for times over ~30s, you need a mount that is aligned to the Earth’s axis (EQ)! Don’t be fooled

Comparison Table

	MSM	iOpt	SWSA
Milky Way	✓	✓	✓
Large Nebula Deepscapes	✓	✓	✓
Andromeda / Pleiades Deepsapes		✓	✓
Comets		✓	✓
Solar Eclipse Corona		✓	✓

Guiding

- Guiding is used to improve tracking performance
- It involves having a CCD camera on a ~135mm lens that is focused on a bright star
- A laptop computer monitors the output of the CCD camera and analyzes the movement. It then instructs the EQ tracker on how to correct for it
- Can greatly extend exposure times, but at a cost of more complexity, more equipment, more cost, and more weight
- I have it and have used it, but don’t anymore. Too much work for what I do

iOptron with Guider

Computer and Cables are not shown