Astrotrac Astrophotography with DSLR

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These days, dark imaging sites are rare and remote. To find an unpolluted sky, the modern astrophotographer has to travel for hundreds and thousands of miles. But those who ever did astro imaging under the pristine skies of La Palma, Namibia or the Alps know the advantages of these dark sites - high contrast, superb color, real depth. Or more technically speaking, really well saturated image sources. That is why a lot of today's astrophotographers are travellers, even if this only means driving out of town or up to the next mountain summit. And when it comes to travelling, portability soon becomes an issue. The lesser the imaging equipment weighs, the smaller it folds, the fewer parts it consists of, the better. In this article we present a dreamteam of instruments that fulfills these requirements in an unmatched way – a DSLR camera riding on an Astrotrac mount. And we point out some best practices that will help you to get the most out of this versatile combination.

The DSLR: In our imaging routine we use a Canon 350D body modified by Baader in Germany for better H-alpha sensitivity. In astrophotography, our 350D as well as any other DSLR has two major advantages over a CCD camera: First, it is a self-contained appliance that needs no additional computer for imaging. Second, it is powered by lightweight internal rechargeable batteries and no external power source is needed. The only trade-off for its low weight and ease of operation is noticeably more noise than a CCD camera shows, especially at air temperatures above 10 degrees Celsius. The lenses we use are all M42 thread lenses of Japanese, Russian and East-German production. In terms of image quality these lenses easily outperform modern standard zoom lenses.

The Astrotrac: Our Astrotrac is a TT320X-AG model, manufactured by Richard Taylor in UK. Before ordering the tracker, we carefully studied user reports of several other portable mounts, like the Takahashi Teegul, the Kenko Sky Memo and the Vixen Photo Guider. It turned out that none is as lightweight as the Astrotrac and none can deliver the same degree of precision. The manufacturer of the Astrotrac promised a tracking accuracy of 5 arcseconds peak-to-peak over a period of 5 minutes, a demanding value which we could confirm in our thorough tests. This means that (accurate polar alignment provided) a DSLR with a 300mm lens can be tracked for this length of time without the slightest hints of trailing. And, best of all, the Astrotrac unit weighs just about one kilogram.

The Dreamteam: Our complete imaging system including the Astrotrac, DSLR, a heavy-duty tripod, several lenses, filters and accessories weighs less than 10 kilograms. It can easily be carried by one person, for the two of us it's a breeze. For air travel, the tripod can be checked in with the luggage. Tracker, lenses and camera go with us. The complete system is up and running in about half an hour, object framing included. After that it's doing its shots automatically for hours. We have been using this system for over a year now, including several trips to La Palma island. After an initial phase of testing and adapting some parts it now works extremely reliably.

How to Get the Dreamteam Running with Optimum Performance

As pointed out, the combination of a DSLR with an Astrotrac tracking mount makes a lightweight, versatile and extremely portable system that allows deep-sky imaging at remote sites. Your imaging location needs no infrastructure and no access road. Where you can go on foot, the Astrotrac/DSLR system can go. Setup becomes easy after some practice and takes no longer than half an hour. Once up and running, the Astrotrac/DSLR system works as a reliable imaging bot that can be left unattended for hours. On one occasion, we actually slept through two hours of exposure.

But you should be aware that, manufacturer's promises aside, astrophotography never is an easy task. Every imaging tool has to be tuned and customised until it works reliably, otherwise only mediocre results can be expected. The Astrotrac mount is no exception to this rule. For those who want to shoot top-notch images with their Astrotrac/DSLR system we compiled the following hints and guidelines:

Start with Short Focal Lengths: Although the Astrotrac system allows tracking of fairly long focal lengths, we highly recommend starting with short focal lengths, let's say a wideangle or standard lens. This will help you get accustomed to the system and develop the needed operational skills for longer focal lengths like 300mm tele lenses.

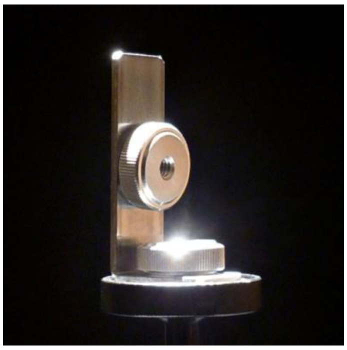
Take a Sturdy Tripod: The Astrotrac system is very well crafted. However, it can only perform reliably when you provide it with a stable base, i.e. a suitable tripod. Cheap plastic tripods are far too shaky and won't work well. A good solution is a quality aluminum tripod with a 2-way pan-tilt head. If the head is geared, it can be used for fine polar alignment. Otherwise, the head is only used for rough polar alignment and precise alignment is done by fine adjusting the tripod legs‘ height and position.

Use the Battery Holder: With the battery pack loaded with a set of 8 alkaline AA batteries the Astrotrac runs for about 8 hours. The battery holder gives you freedom of external power sources, a fact that can't be valued enough when it comes to mobility. We recommend keeping the battery holder inside a small camera bag, available in any camera store. This keeps the batteries away from the often inevitable dew.

Secure the Polar Scope: During operation, the polar scope is held in place by three tiny magnets on the underside of the Astrotrac's polar scope arm. Since the polar scope arm and the camera body are in close vicinity to one another, it is easy to bump into the polar scope, especially in the dark. To prevent it from falling down (and losing its collimation, to name the least) a short piece of 3/4 inch tubular pipe insulation can be used. Simply snap it on to the polar scope.

Use a Timer: The Astrotrac system runs fully automatically for hours. To automate the entire imaging process an additional camera timer is needed. With a device like this it is possible to program a series of exposures. After that, the push of a button starts an automated imaging sequence. This leaves you plenty of time to enjoy the beauty of the night sky.

Use a Heavy-duty Ball Head: The ball head is the point most likely to show flexure. So, don't betray the high accuracy of your Astrotrac system by using a ball head too weak. The ball head has to support the full weight of your DSLR including its lens. When imaging with optics in the range of 200/300mm focal length, the total camera weight can amount to 3kg or more. Before selecting a ball head for your Astrotrac system carefully study its specs, especially the maximum weight supported.



Restore Freedom of Camera Orientation: Using the Astrotrac with a ball head is sufficient to aim the camera at any point in the sky. However, for the area between the celestial pole and the zenith the camera does not have full freedom of orientation. A simple 90° angle bracket between the camera and the ball head solves this problem and restores the full range of movement in this section of the sky. Since such brackets are not available as standard equipment, we customised one ourselves.

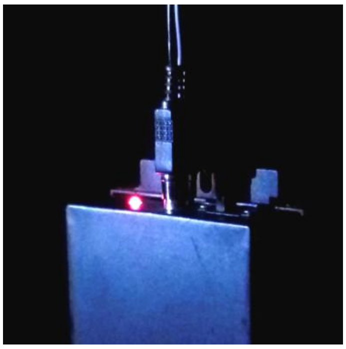
Use a Right Angle Viewfinder: Framing a celestial target with the camera body's viewfinder often doesn't work out. Especially when a target is high in the sky it becomes nearly impossible to look through the viewfinder. Therefore, a right angle viewfinder with a magnification of 1x is of great help. This invaluable accessory is available for any DSLR and simply gets snapped on to the camera's viewfinder.

Focus the Polar Scope: To achieve high accuracy polar alignment it is necessary to work with a well-focused polar scope - meaning that objects at infinity (e.g. Polaris) and the reticle marks have to look sharp at the same time. Adjust your polar scope until this is the case. Otherwise, tiny movements of your head will cause the alignment stars to shift against the reticle marks and your polar alignment will not be precise.

Collimate the Polar Scope: To allow for high-precision polar alignment, the polar scope's reticle has to be aligned with the scope's rotational axis. For collimation, aim the polar scope at a terrestrial target. Rotate the scope and watch how the target circles around the reticle's center. Adjust the reticle in the field of view until the target stays dead center when rotating the scope. Since three very tiny screws on the polar scope have to be used for this alignment, this can be a tiresome process.

Collimate the Polar Scope Arm: The polar scope must always stay parallel with the Astrotrac's axis. Again, aim the polar scope at a terrestrial target. This time, rotate the polar scope arm and notice the target's movements. To eliminate the target's movements, small pieces of duct tape can be applied between the polar scope and the polar scope arm. Once you've found the right positions for the tape strips, stick them permanently to the polar scope arm.

Do a Final Re-Alignment: Most certainly you do the Astrotrac polar alignment before framing your target with the camera. But don't forget to do a final re-alignment before starting your actual exposure series. During object framing the position of the camera weight on the Astrotrac mount usually shifts, letting the initial alignment slip a litte.



Heat Your Optics: The night sky your optics look at has a temperature of 3 degrees Kelvin. Hence your lenses loose a lot of heat via thermal radiation, cooling way below air temperature and hitting the dew point on many nights. The only reliable way to cope with the resulting dew is to apply extra heat to the optics. We customised a miniature dew heater, which consists of a 4.5V battery pack and provides 2W of heat to our lenses. The commercial 12V products did not meet our demands for high portability.

Avoid the Astrotrac Light Trap: For those imaging with a DSLR there is a nasty trap built into the Astrotrac system. It goes by the name of green flashing status light. Some camera positions allow this green light to enter the camera body through the viewfinder, which later shows on the images as a faint green glow. In any case it is very wise to cover the camera body's viewfinder during the actual exposure series.

Shield Against the Wind: Astotrac imaging with longer focal lengths is pretty sensitive to wind. Our experience shows that wind stronger than 2 Bft should be avoided. So finding a nice place that is shielded well from the wind is often the most challenging task of setting up the imaging system. It doesn't make it easier that this place must provide a free line of sight not only to the celestial pole but to the imaging target as well. The picture shows a 100% crop of a test shot with 200mm focal length at 5 Bft.

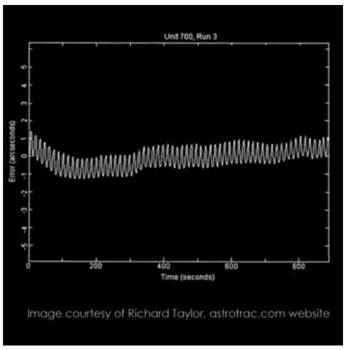
Keep Exposure Times Within the Tracking Limit: The specified tracking precision of 5“/5min is a very good value for such a small device as the Astrotrac. It perfectly matches the precision needed for a 5min exposure with a 300mm lens and a typical DSLR. In our experience, with 300mm f.l. this upper limit should not be exceeded for pinpoint star images. Exposures with shorter focal lengths are less affected by tracking precision. They are mostly limited by the obtainable polar alignment precision.

Maximum Exposure Times*

50mm	20min
135mm	8min
300mm	4min

*) to achieve pinpoint star images with a typical DSLR (pixel size ~6μm) and a polar alignment precision of ±5 arcmin

Keep Exposure Times Within the Alignment Limit: Even with a well collimated polar scope and a well collimated polar scope arm your alignment will have residual deviations. They limit the obtainable polar alignment precision and the maximum exposure times, when pinpoint star images are desired. The maximum polar alignment precision of our unit is 5 arcminutes. This translates to maximum exposure times for different focal lengths as specified in the table to the left.



Trust the High Precision Tracking: The manufacturer claims a tracking precision of 5 arcseconds peak-to-peak within 5 minutes. We field-tested our Astrotrac unit for tracking precision and found exactly the same value. So if there are trailed stars on your images the reason most likely is not bad tracking precision. Trailed stars hint that either your polar alignment was off or a part of your mounting hardware (e.g. tripod, ball head,...) showed flexure.

Precise Polar Alignment is the Key

As you may have noticed, the key to well tracked images with Astrotrac is precise polar alignment. To prepare your unit for imaging, take your time to focus the polar scope and collimate the polar scope as well as the polar scope arm. This can be done during daylight. Out in the field, first perform a rough polar alignment on Polaris and then do a second, precise polar alignment after framing the object. To achieve good results with your Astrotrac these steps are absolutely mandatory.

A Final Note About Imaging with Longer Focal Lengths

There are some Astrotrac features, accessories and techniques that allow the use of longer focal lengths and longer exposure times than described in this article. For once, there is the autoguiding feature of the newer AG models. To use this feature an additional autoguider and a separate guide scope are needed. Since Astrotrac autoguiding only works in RA, a higher polar alignment precision is needed too, meaning that time-consuming drift alignment becomes neccessary. And with longer and heavier focal lengths of more than 300mm one will want to make use of the available wedge, Dec arm and pier as well. Since all this weight and complexity of operation stands against the core feature of the Astrotrac system (maximum mobility) we never used these options. But anyone operating the Astrotrac system stationary might want to consider them.

All images of this article are by the authors, except where otherwise indicated. The images of the Milky Way (f=50mm), Antares Region (f=50mm) and Rosette Nebula (f=135mm) illustrating this article were all shot with 4min subframes from a rural site on La Palma island with an EOS 350D riding on an Astrotrac 320X-AG.

The authors Karoline Mrazek and Erwin Matys are founding members of the astrophotography group project nightflight. Check out their images, tests and tools at www.project-nightflight.net.