

# Auto Guiding using Atiks Capture Software

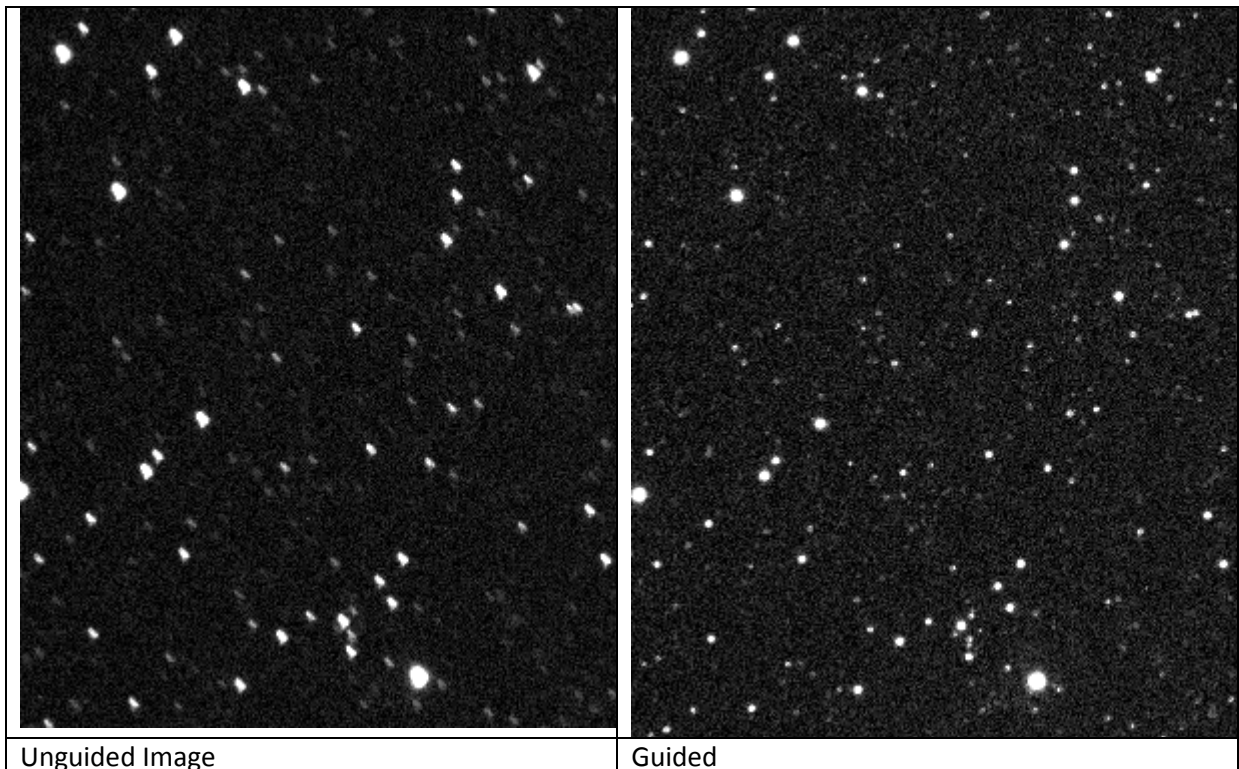
Steve Chambers

## Introduction.

Moving from taking unguided to guided pictures is often seen as the biggest step in developing skills as an Astro photographer. To many it can appear a black art with many software settings and tricks. But once mastered it opens the way to taking fantastically detailed pictures of extremely faint targets. In this article I will endeavour to give a general overview of guiding partially with reference to our Capture software. However, this is not meant to be a complete guide of which buttons to press, rather I hope you will find the information here that will allow you to make decisions on how best to auto guide your telescope.

## Auto Guiding – What is it?

When taking Astro photos without guiding the pictures generally look OK at shorter exposure lengths but as the exposure duration is increased the stars trail into lines rather than staying as points.



This trailing is rather unsightly and robs an image of its fine detail and dimmer stars become lost in the background as their light is spread over more pixels. The causes we will come on to shortly but it is basically the mounts inability to accurately track a star as moves across the sky.

In the days of film astrophotography (not long ago but nearly forgotten), astronomers would use a guiding eyepiece with a crosshairs centred on a bright star. During the exposure, which could last an hour or more, the astronomer would sit looking into the eyepiece and making small adjustments to the telescopes mount to keep the star centred on the crosshairs. In this way the telescopes aim was maintained and trailing avoided.

The “auto” in auto guiding refers to using an electronic camera instead of the crosshairs eyepiece and a computer to make the corrections. Once set up correctly this has the huge advantage that the astronomer does not need to concentrate for hours at an end at the eyepiece but is free to enjoy the night sky or go inside for a nice cup of tea.

## **Equipment required for auto guiding.**

In my opinion the most important part, or at least the most under estimated part, of an Astro imaging setup is not the telescope or camera but the mount. This needs to be a type with one axis parallel with the Earths rotation eg German equatorial, fork mount on a wedge etc. Using mounts such as a fork without a wedge will introduce what is known as frame rotation. The mount needs to be able to accept guiding corrections. Typically mounts now have computer connections to link to a laptop or PC which can be used. However it is possible to guide non computer linked mounts if they have a guider port. The industry standard is known as an ST4 port. In this case the connection is made between the guide camera and the mount using a 6 way cable.

In order to guide an imaging camera / telescope combination we need to introduce a guide camera and a guide telescope on the same mount as we are using for imaging and pointing at the same part of the sky.

An often quoted rule of thumb is that the guide scope should have a focal length of at least twice that of the main telescope. This advice harks back to the days of manual guiding where the long focal length telescope would give high magnification and allow the operator to see easily if the star drifted from the cross hairs eyepiece. When we use a camera as an auto guider we can use shorter length guide scopes as the computer can detect much smaller movements of a guide star (typically 0.1 pixel or less). I would suggest a guide scope should be between the same focal length of the main scope to half this value. This allows the guide camera to see a larger section of sky to give more potential guide stars.

As an alternative to using a separate guide scope it is possible to use a device called an off axis guider. These are small prisms introduced near the edge of the field of view which divert a part of the image 90 degrees to a guide camera. The image from an off axis guider can be rather faint, have a very small field of view, and have distorted stars. But its advantage is comes from using the main telescope so a second guiding scope is not required (and potential errors arising from flexure between main and guide scopes is not a concern). For completeness, dual CCD cameras can be considered as a type of off axis guiding.

Guide cameras can be anything from a webcam to a high spec cooled CCD camera. As the guide camera is not used for imaging it's possible to use a less expensive camera. However its worth not compromising too far. The camera will need to take short exposures of faint stars so its need to be able to produce images with good signal to noise. The amount of signal a camera can produced is largely limited by the brightness of a star and is independent of the camera. The noise is very much related to the camera. Its well worth using a low noise cooled CCD as these will produce significantly better images than an uncooled guiding with higher image noise. The better images make for better

auto guiding and so better final astro images. We recommend the Atik 161C as the ideal guide camera.

The last piece of the jigsaw is a computer to take the image from the guide camera and calculate the required correction to issue to the mount.

## Errors – what errors?

We know unguided images don't show pinpoint stars due to errors in the telescope not accurately tracking the stars motion across the sky, but what is giving rise to these errors and what effect do they have on the image.

- Periodic errors – As the name suggests these errors repeat every few minutes and the predominantly related to the mounts worm gear. This will turn one revolution in 4 minutes (for a 360 tooth wheel) . Any machining or mounting errors will reveal themselves as movement in the RA axis. As the errors reoccur every few minutes some mounts will attempt to correct for this )periodic error correction ,PEC)
- Alignment error –The RA axis of the mount should be aligned with the celestial pole. Deviation in this alignment will cause stars to appear to drift across the field. The direction of this drift depends on where the RA axis is pointing and also the part of the sky the telescope is pointing. In long exposure images with poorly aligned mounts the image appears to rotate around the guide star.
- Play – This can be extremely problematic. Typically both the axis's of a telescope will have a small amount of play. If this is reduced too much the drive gears can start to bind and the motors are put under a lot of strain. Play can result in random movements of the telescope, for example, if a gust of wind catches the scope.
- Flexure – Even if the mount is perfectly aligned and has a perfect drive you can still get trailed stars. One common cause is flexure in the focuser. If the focuser tube has a bit of 'wobble' and a heavy camera is attached the result can be flexure that changes as the scope tracks the stars. Again this shows up as elongation of stars in one axis.
- Seeing – Included for completeness. When viewed at high frames rates stars appear to dance around. This motion is caused by refraction in the atmosphere.

## Correcting for the errors – Autoguiding.

Let's consider how we can minimise these errors, especially with regard to auto guiding.

- The majority of periodic errors can be eliminated using the mounts PEC if available. The reason for using PEC rather than just guiding the error out is that PEC within the mount will try to stop the deviation from happening. Guiding can only correct the error after it has happened. To program a mounts PEC an auto guider can be very useful but is a little outside this article. Remaining PEC or periodic error from an uncorrected drive can be effectively eliminated by auto guiding.
- Alignment errors are effectively handled by an auto guider which will issue commands to the mount to counter act the drift. Auto guiding cannot correct for frame rotation from a very poorly aligned mount.

- Play is a real bugbear. The auto guider still try to bring a guide star back into position but calibrating the guider in the first place can be nearly impossible if the mount has a lot of play.
- Flexure. Introduction of a guide scope can actually lead to more sources of flexure. To get the best from auto guiding it's important to reduce sources of flexure.
- Variations in star position and focus due to seeing cannot be reduced by a conventional guider issuing drive corrections to a mount. Some "Adaptive Optics" systems claim to be able to do this but it's unlikely that any improvement in image quality on using an AO system is due to correcting for seeing.

## **Starting Autoguiding with Capture.**

When starting autoguiding I would strongly suggest that a whole night of clear skies if given over to setting up the system. A night close to a full moon would be ideal. Start by getting a well focused image on the guide camera. At least one star should be bright enough to give a pixel value of approx 10,000 in a 1 second image. Avoid having any saturated stars in the field.

The key stage is calibrating the mount. Here the software will try to move the mount a very short way in each axis and look for differences in the image. Problems may occur if the mount moves too far or not enough. Just by looking at the screen you should be able to see if it's the former. In which case it's worth reducing the Calib time (ms). If the star does not move then try again with a greater Calib time (ms). If this does not work you need to check the connections between mount and PC and that this is reflected in the ASCOM or Camera Relay option box.

After a successful calibration set the autoguiding to active and monitor the graphs. You will see corrections being made by the green lights turning red. See if you can improve the guiding by changing the feedback values, or limiting the guiding to just the RA axis. Finally it's worth slightly unbalancing the mount in RA to see if this improves guiding.

You can see a video of the calibration and guiding process in Capture on the Atik Website.