Collimation of a SCT

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1 Introduction

To obtain the best visual and photographic images through your scope it must be collimated which is the practise of ensuring that the telescopes optical components are aligned to one another.

This document explains how to collimate a SCT (Schmidt Cassegrain) scope, in my case it is my Celestron C11. Collimation for this type of scope involves making adjustments to the secondary mirror which is fixed to the scope's corrector plate via a set of small screws (or cap head bolts) provided specifically for this purpose while observing the shape of a defocused star. These screws allow the tilt of the secondary mirror to be finely adjusted until it aligns with the secondary.

This article also details a home-made collimation aid that is simplicity itself to make.

Rather than use a (reticule) eyepiece to observe a defocussed star during the collimation process I use a ZWO ASI178MM camera set up in a "straight through" mode working at the scopes native f10 as shown below. I then use the image zoom function provided by the *SharpCap* capture software so as to enlarge the star image and provide suitable magnification.

Figure 1 - Collimation via a ZWO ASI178MM camera

2 Collimation

2.1 Procedure

1. Allow the scope to stabilise with the ambient temperature.
2. Select an eyepiece that gives you about 250x magnification or use a CCD/CMOS camera with the image zoomed in on the image capture software. If using an eyepiece it's best to use a reticule eyepiece which allows you to accurately re-centre the subject star between each adjustment.
3. Centre a fairly bright star (around mag 1 will do nicely). Centralising the star is very important as most SCT's exhibit image degradation issues nearer the edge you get, so this is where a reticule view (on eyepiece or software) helps to get the position spot on.
4. Defocus the star so that you get an image that looks like a donut as in the example below (the red lines represent a reticule's cross hairs view which is optional).

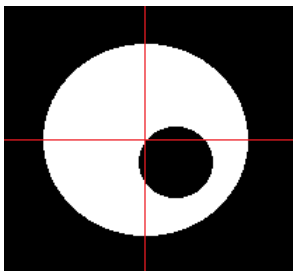

Figure 2 - Out of collimation star representation

5. If your collimation is good then the 'hole' in the middle of the donut will be in the centre, if it is offset (as in the example above) then you need to adjust your secondary mirror.
6. Adjust the applicable screw (see section 2.2 below for an explanation of which screw to select) – **make very small adjustments**, no more than 1/8 turn.
7. Re-centre the star in the eyepiece/software view to check the effect of the adjustment.
8. Repeat as required until the 'hole' is perfectly central – remember to re-centre in the eyepiece after every adjustment.
9. Repeat using as high a power eyepiece/software zoom as you can comfortable use on a dimmer star (around mag 3 is fine).
10. The view should now be as follows, which shows perfect collimation.

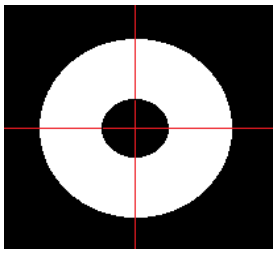

Figure 3 – Collimated star representation

2.2 Which collimation screw to adjust

The conundrum during collimation is to determine which collimation screw to turn and in which direction.

Unless you have unfeasibly long arms then trying to look through the eyepiece while stretching round the scope and adjusting the screws to gauge the adjustment will be impossible. Its much easier to use a CCD/CMOS camera to image the defocussed star and observe it on a screen while adjusting a screw which should make life a lot easier.

All SCT's that I have seen have three collimation screws (or cap head bolts), such as the image of my C11 in the section below. The screw you need to adjust so that the 'hole' is centred in the donut is the one that is opposite the thinnest or fattest space of the donut as shown in Figure 4 below where the blue numbers identify the screw to adjust.

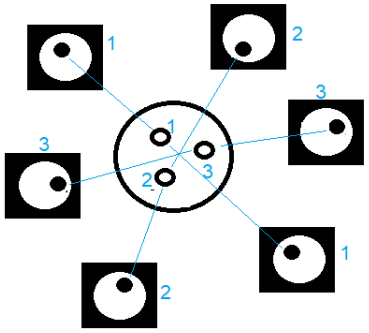

Figure 4 - Collimation screw identification

The three screws must be adjusted in an antagonistic manner, i.e. if you loosen one then tighten the other two by the same amount. If you find your adjustment it the wrong way (i.e. the donut symmetry gets worse) then just do the opposite and make a note of the correct way for you scope. Only make **very fine adjustments** to each screw, usually no more than 1/8 of a turn or less.

You must also be very careful not to scratch your corrector plate with a screwdriver / Allen key while making adjustments so it's far better to be comfortably in front of the scope when you make any adjustment rather than trying to stretch around it. To facilitate this I manufactured the collimation aid shown in the section below by cutting it out of a sheet of hardboard. This sits over the end of my scope and I simply rotate it so that the shadow of the arm as seen through the eyepiece lines up with the thinnest or fattest part of the donut, you then move to the front of the scope and the arm is pointing at (or covering) the screw you need to adjust (i.e. the arm is the physical representation of a blue line in the figure above).

That's the theory, but you may of course just try any screw and if the image gets better make a note of it, if worse try another one until you work out the correct relationship.

2.3 Homemade collimation aid

The images below are based around my Celestron C11, the star donut images have been taken via my Canon SLR, but this is only for explanation purposes as use of a CCD or SLR rather than an eyepiece will not give you the magnification required to make sensitive enough adjustments.

Figure 5 - Typical collimation screws (Celestron C11)

Figure 6 – My homemade collimation aid

The image below shows my collimation aid in place, while checking the defocused star donut through the eyepiece I simply rotate it so that the shadow of the arm as seen through the eyepiece lines up with the thinnest or fattest part of the donut. The screw to adjust is the one closest to the centre line of the arm.

Figure 7 - Collimation aid in place

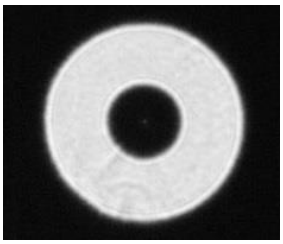

Figure 8 – Image of a star donut without collimation aid in place

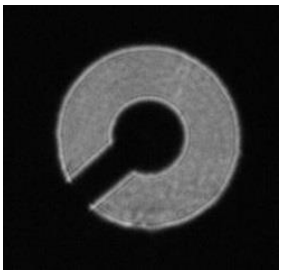

Figure 9 – Image showing the collimation aid's arm shadow

3 Further Information

Please visit my website www.astroworkbench.co.uk for further documents and articles.

Thanks.

Keith.