My home-made focus readout system. Gordon Lloyd, 05/01/11

This paper is about 2 improvements I made to my telescope focuser, mainly for Deep Sky photography.

1 A home-made, focus position read-out device for my Revelation, Crayford-type, focuser. This relies on friction instead of a rack and pinion. There is therefore no rigid connection between the focus knob and the drawtube which could be used as a position read-out.
2 A sprung push-rod to balance the weight of a camera and avoid focus slippages.

Before I had this device, my tedious method of working, for fainter objects, was as follows:

1. Point the telescope at a fairly bright star near the object to be photographed.
2. Replace the eyepiece with my Canon EOS 450D camera, without its lens, on its Canon bayonet-2 inch telescope adapter. Its viewfinder, and “Live View” facility, with its x10 zoom, would show the star and I could easily focus on it very accurately. ***Lock the focuser.***
3. Remove the camera and replace the eyepiece. This would give an out of focus image because the focus position of the eyepiece is about 5mm further out than with the camera.
4. ***Without unlocking the focuser lock***, undo the eyepiece retaining screw in the drawtube and slide the eyepiece outwards about 5mm to re-focus it.
5. Using my GOTO facility, move the telescope and centre it on the actual object to be photographed.
6. Remove the eyepiece and re-fit the camera.
7. Take some quite long exposure test photos of the object and see if it was a) in the field of view at all! b) in the centre of the field of view. c) in precise focus.
8. After any other camera adjustments required, take all the photos required, ***checking the focus of the photos at intervals.***

This was a tedious and unreliable process. I therefore decided to make a focus position read-out device. These are now available on the market, but were not then.

Focus readout range, resolution and accuracy requirements

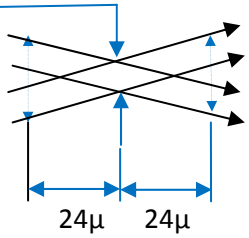
The pixels in my Canon camera are 7 microns square. The telescope’s focal length is 1200mm. Therefore, at prime focus, thus ***each 7 micron camera pixel covers 1.2 arc-seconds.***

The “Airy Disc” of my telescope is equivalent to a blur about 0.5 arc-seconds, or 3 microns across.

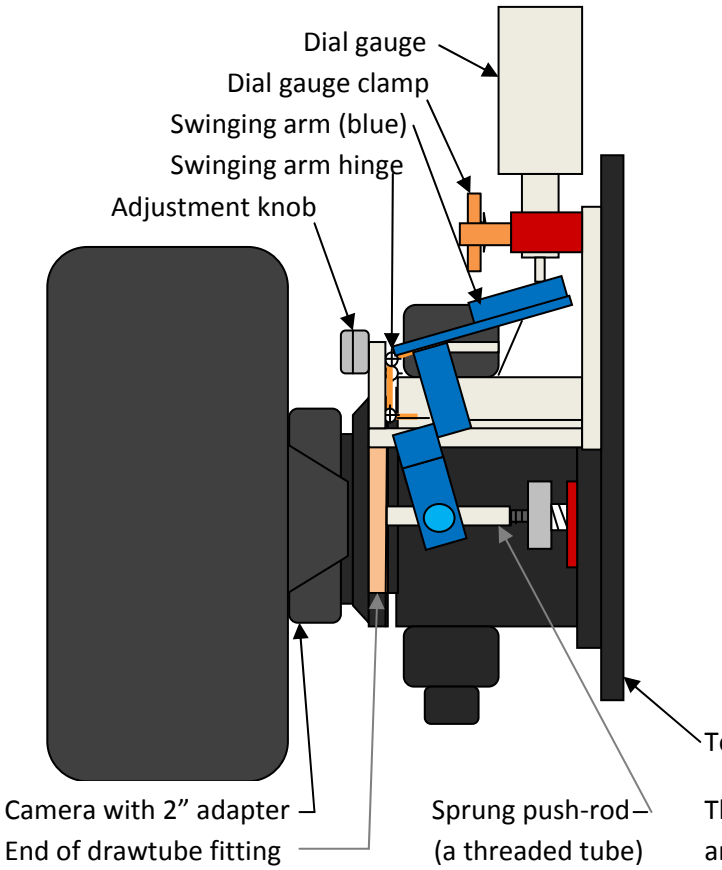
With typical “seeing” conditions, the image “blur” is from about 1 to 2 arc-seconds across, or 6 to 12 microns.

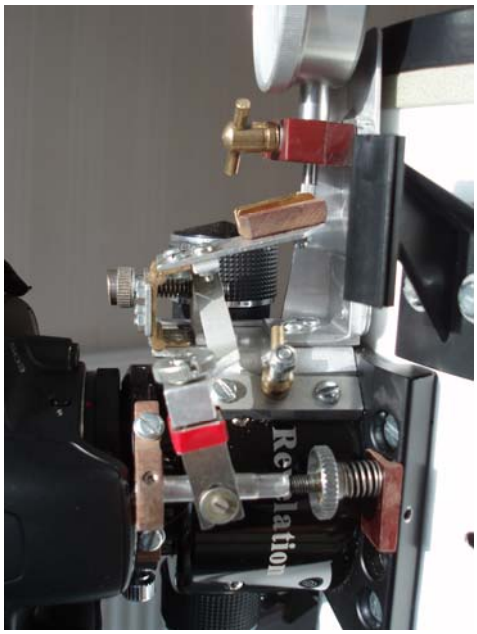
It is clear therefore that my 7 micron camera pixel size, and realistic conditions are fairly well matched at about 6 to 12 microns “blur” diameter.

My telescope’s focal ratio is 4.8. For a minimum “blur” of, say 7 microns across, the converging cone of light will reach 12 microns across about 24 microns each side of ideal focus. So ± 24 microns is about the focusing accuracy required.



The following page illustrates the focus position readout and sprung push-rod system.





The black parts are original. The silver, red and brown parts are my construction. The actually silver parts coloured blue in the sketch are the parts of the swinging arm.

<u>The final design</u>

I used an “One Inch” (~25mm) engineering Dial Gauge with 0.001 inch divisions, (~ 24 microns), as required. This has 0.1 inch/revolution, with a small dial showing full revolutions.

I settled on a 90° swinging arm design. The mechanism is fairly self-evident from the photo and diagram above. To go “round” the focuser itself, the arm is bent “towards” the viewer above, and arrives next to the focuser where the push-rod to the focuser drawtube end is placed. A screw inside the push-rod allows a variable spring force to be applied to the drawtube, against the focuser (red) to balance a heavy camera.

To make fine adjustments to the dial gauge zero, the swinging arm’s hinge is itself movable by a short screw and adjustment knob (both labelled).

My revised method of taking photos – compare this with my original method on page 1.

1. Point the telescope at a fairly bright star near the object to be photographed.
2. Replace the eyepiece with my camera. Focus the camera and set the dial gauge to zero.
3. Replace the camera with the eyepiece. Re-focus on the star.
4. Move the telescope to the actual object to be photographed, or where it should be!
5. Take a quite long exposure test photo of the object to check the object is in frame, focus etc.
6. Take all the photos required, *<u>checking the focus of the photos at intervals.</u>*