Testing a Ritchey-Chretien Telescope for Spherical Aberration

This note attempts to aid the testing of an RC telescope for spherical aberration using a Ronchi grating eyepiece and records my own experience doing this with an 8-inch Ritchey-Chretien.

The focal length of an RC telescope varies with the separation of the primary and secondary mirrors:

$$F = f1\frac{(b+D)}{(f1-D)}$$

Where

F is the focal length of the system

f1 is the focal length of the primary mirror

b is the distance of the focal plane from the primary mirror

D is the distance between the primary and secondary mirrors

As best as I could measure, the parameters for my 8-inch RC are:

D = 344.5 mm

f1 = 580 mm

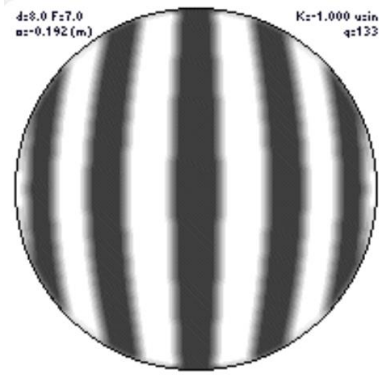
b = 315mm

and then F= 1624.25mm (as advertised)

Here is the Gerd Neuman Ronchi grating installed on my camera.

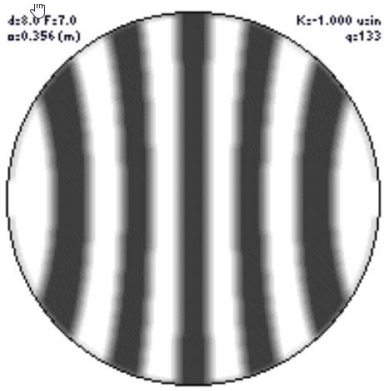
Ttesting of my RC with a Ronchi eyepiece revealed these patterns:

Rocking the eyepiece to inside focus:



Inside focus, I had a barrel-shaped Ronchi pattern.

Rocking the eyepiece outside focus:



Outside focus I had a pinched pattern.

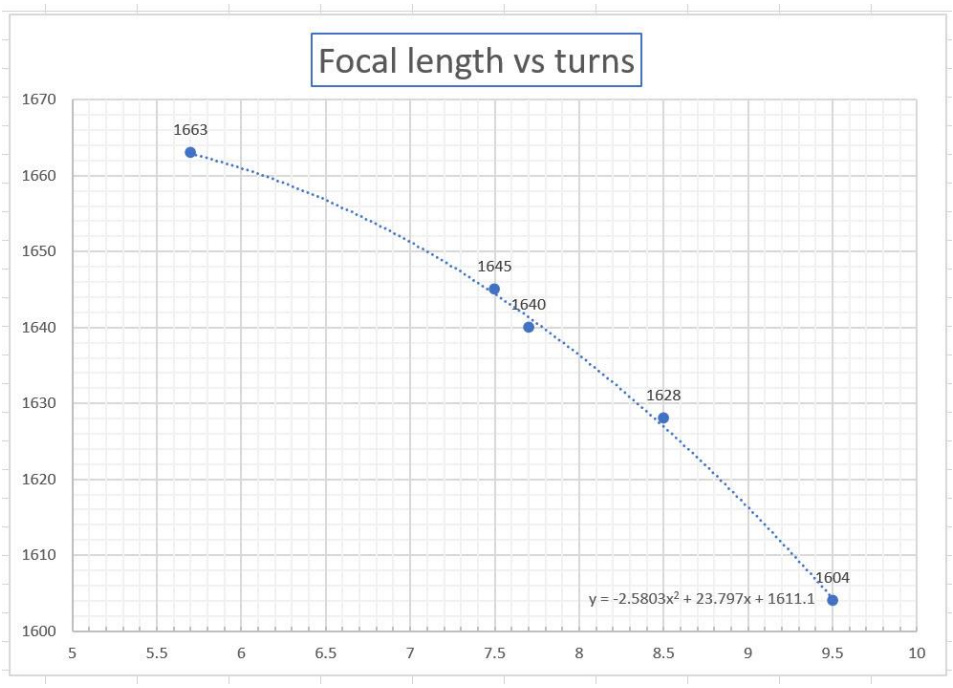
The telescope was over-corrected, and I had spherical aberration, i.e. similar in appearance to using a spherical mirror.

The primary and secondary mirrors were too far apart.

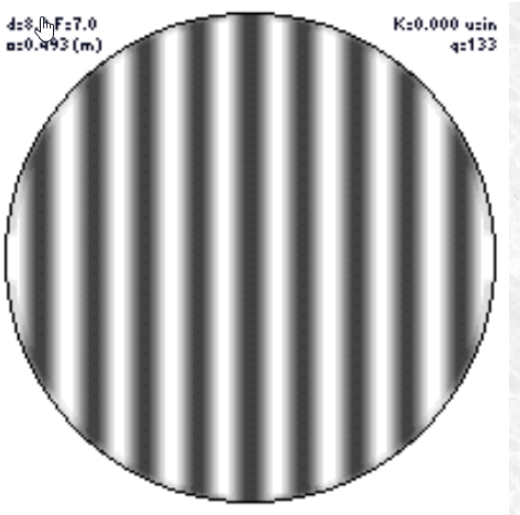
Light rays from the outer edge of the mirror were brought to focus further from the mirror than light rays from the centre of the mirror.

If the opposite was true, i.e. I had a pinched pattern inside focus and a barrel-shaped pattern outside focus, then the scope would be under-corrected. The mirrors would have been too close together. Light rays from the outer edge of the mirror would be brought to focus closer to the mirror than designed.

I undertook to characterise the variation of focal length with the number of turns of the centre screw of the secondary mirror and got this curve:



I changed the focal length by unscrewing the secondary centre screw. I did this half a turn at a time and with each adjustment, I also tightened the three collimation screws an equal amount – screwing them in. After three full turns of the secondary centre screw – equivalent to moving the secondary in by 3mm, I got a good Ronchi test each side of focus.



So the telescope focal length turned out to be 1660mm, not 1624mm.

Following this exercise, I recollimated the telescope.

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