

ATM Journal 7: Testing Your Mirror Part 2

By Gordon Tulloch, RASC Winnipeg

Last time, we looked at how null testing of spherical and paraboloidal mirrors work, and in particular basic principles on how the Foucault Test works. This time we'll review the basic procedure for the Foucault test with a Couder mask, and look briefly at a vastly easier way of accomplishing mirror testing with the aid of a digital camera and computer program. Once you can test your mirror and see what the shape looks like as a sphere, we can move towards a paraboloidal figure next article.

The classical Foucault Test involves measuring the focal length of various zones of your mirror by measuring where the shadow of a knife edge blocks out (nulls) the zone of the mirror being tested. To make this easier to see on the face of the mirror, one normally uses a Couder Mask (the easiest way to generate the mask is using the program "Tex" (standing for Texereau) which does Foucault data reduction, as well as printing masks (you may need a program named Ghostscript to convert the resulting image to PDF format for printing if your printer doesn't understand Postscript). We'll assume for the purposes of this article you have a three zone mask as below, although depending on your mirror you may have 4 or more.

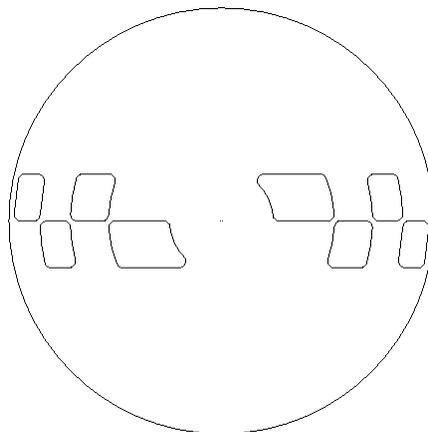


Figure 1 - Couder Mask with four zones

In general (for a far more exhaustive treatment, see Texereau or <http://www.atmsite.org/contrib/Harbour/Foucault.html>) the procedure is as follows:

1. First off, allow the mirror to cool on a stand (such as the one you can build from the Stellafane site) to ambient for as long as is required. Just as temperature will change the figure of the mirror out in your telescope, so the figure will change if you have been polishing and immediately put the mirror on the stand.
2. Set up your tester at a foot less than twice the Focal Length (i.e. the centre of the Radius of Curvature) away from the mirror aligned with the optical axis. A common mistake is to set the tester at the Focal Length, which will result in seeing a nicely focused image of the tester reflected, useless for testing.
3. Depending on your mirror you may need to start with your tester close to the mirror and slowly back away, keeping the image of the LED in your tester centered in the mirror, until the light from the LED completely fills the mirror with light. Alternatively, I use a laser pointer to center everything since the laser will project a dot on the tester stage (or the wall behind you if you're really off centre) so you can line everything up.
4. Position the tester at the ROC – you can tell this by tilting the stage such that you can see the shadow of the knife edge moving across the face of the mirror. If the knife edge comes into the image from the same side the knife is physically on, you are INSIDE the ROC. If the knife edge appears to enter the image from the opposite side, you are OUTSIDE the ROC. If the image of the mirror “greys out” all of a sudden, you're at the ROC. Another indicator of being in the right spot is that you can see air currents and turbulence floating across the

face of the mirror like heat waves off an asphalt surface. Practice bringing the knife edge in and out of the image and moving the stage back and forth. As you move the stage, you'll see the surface contours of the mirror in stark relief even though the variations are on the order of millionths of an inch.

5. To perform the test, put the mask on the mirror, and move the stage back and forth perpendicular to the optical axis until the knife edge darkens the centre zone (as seen through the Couder Mask) all at once (rather than being seen to enter from the right or left as above). This is your 0 point – the meter on your tester should be noted and all other measurements will be in relation to this point.
6. The left zone 2 opening will appear to be lighter than the right – draw the knife edge further back along the optical axis until both zones appear equally lit, and note the reading on the meter. Continue on to the third and fourth zones similarly.
7. Upon finishing off the last zone, work your way back through the zones until you have reached the centre zone, recording the numbers along the way. This will provide a check on the numbers originally entered.
8. Using the Tex program, enter your readings. Remember that the Stellafane tester is a moving source tester so the program can calculate the numbers for you. If you're computer challenged, see Texereau for a manual method.
9. Tex will automatically calculate a numerical representation of the surface figure of your mirror for you – you can even graph this data so you can see relative departure from a “perfect” paraboloid for your mirror. Once you know where you have to “shave” some glass off, you can take action accordingly during figuring.

I've always found manually testing mirrors to be tedious so I was pleased to discover a program on the Internet at foucault.sourceforge.net that completely automates the task of testing the zones on your mirror. Essentially, the user takes a series of digital camera photos of a mirror from the same point of view one might test using more traditional methods.

To do this I built a stage onto the back of my Stellafane Foucault tester (as described previously) and mounted my Olympus 3040Z digicam to it so that the camera is looking past the knife edge at the mirror – i.e. exactly where you'd place your eye if manually testing. Setting the camera 1 cm in front of focus, I took 20 low resolution (640x480) shots, moving the camera 1 mm back at a time until I was 1 cm behind focus. These 20 shots are input into the Foucault program and are selectively analyzed to provide a very accurate map of the figure on your mirror, similar to that which can be calculated by traditional methods but with far greater consistency and objectivity. Highly recommended! Note: extreme care must be exercised to ensure that the tester is aligned with the optical axis of the mirror or unacceptable error will creep in.

You may have ended up the polishing stage with a perfect sphere, a paraboloid, or some other figure of revolution. Now that we know what the figure of your mirror is, we'll look next time at how to change the shape of your mirror into a paraboloid, and some ways to fix problems that might occur during the process. As always, questions or comments are welcome at gtulloch@shaw.ca.

Conclusive proof that there is life on Mars! . . . next page