

0. Introduction

This document describes my experience of collimating a 14" RC for the first time. It is based on the famous DSI method but I found the official document confusing and got nowhere implementing it. This is my attempt at making it clear, simpler, and idiot-proof.

This method relies only on visual inspection of images to iteratively converge toward the collimation point. It doesn't require any collimation tools. Collimation tools aren't advised as they assume mechanical or optical alignment of the telescope, which is not necessarily true.

This method applies to collimation when the collimation point isn't too far from the frame; ideally within the frame. If your collimation is extremely far from the field of view, it is harder to implement.

1. Requirements

- Ritchey Chretien telescope.
- Camera mounted in the focuser.
- Tools to collimate primary and secondary mirrors.
- Knowledge of the DSI guide to collimation (http://www.deepskyinstruments.com/truerc/docs/DSI_Collimation_Procedure_Ver_1.0.pdf).

2. Overview

The high-level process is the following:

- Slew to a very bright star and center it in the frame. The best is a bright star surrounded by a star field.
- Defocus toward telescope enough to see a doughnut where the bright star is when no stretch is applied.
- Take very short exposures of the star in a loop. No stretching.
- Using primary, fix doughnut distortions as well as possible using the primary mirror and the DSI method.
- Stop exposures and move toward focus a bit.
- Take a 20 seconds exposure of the field and stretch it.
- Look at the shape of the stars and note where the best stars (roundest) are.
- Defocus back to the most defocus position as at the start of the process.
- Take short exposures in a loop again.
- Move the center star in the opposite direction to the roundest stars compared to the center of the frame using the secondary mirror. You can also think of it as moving the nice stars to the center of the frame (but it's harder to have a good reference point once you switch to short exposures, as the weak stars will disappear). It's easier if you put your cursor where you want to go first and just adjust the secondary mirror iteratively until you reach your goal.
- Note the movement you made so that you can revert it if you made things worse. Screen captures are a good way to do it.
- Recenter the star using the telescope coordinate controls (racket).
- goto d).

3. Applied example

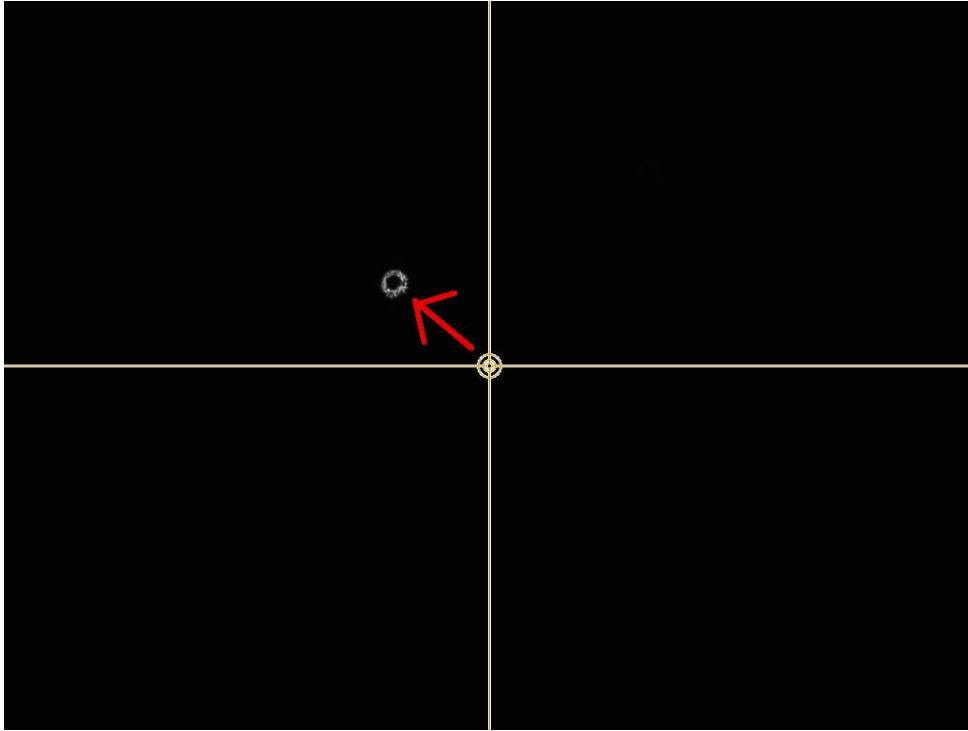
Select a bright star (mag 1 or 2) high up in the sky.

Starting point:



The field suffers from few stars. The focal length of the telescope was 2840mm and the camera sensor was small.

Looking at the stars, it appears that the stars toward the bottom right corner look rounder than the stars in other parts of the frame. The first movement will therefore to move the center star toward the top left corner of the frame. Use the secondary mirror collimation screws for that and don't stretch the image.

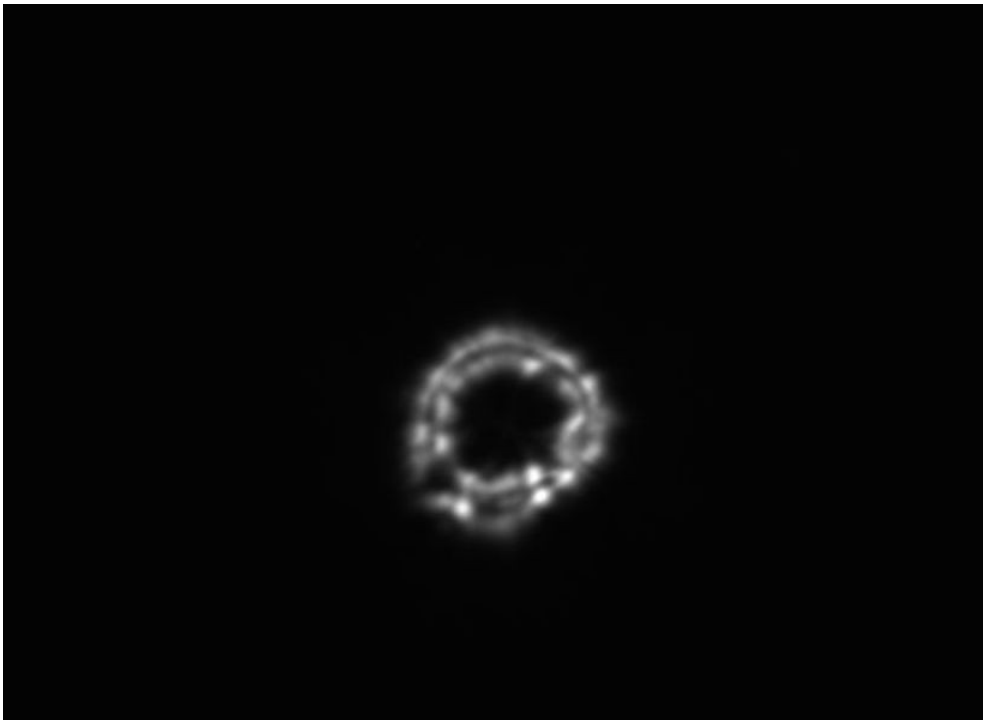


Recenter the star using the telescope coordinates control commands.

Then using the primary, adjust the appearance of the star using the DSI method:

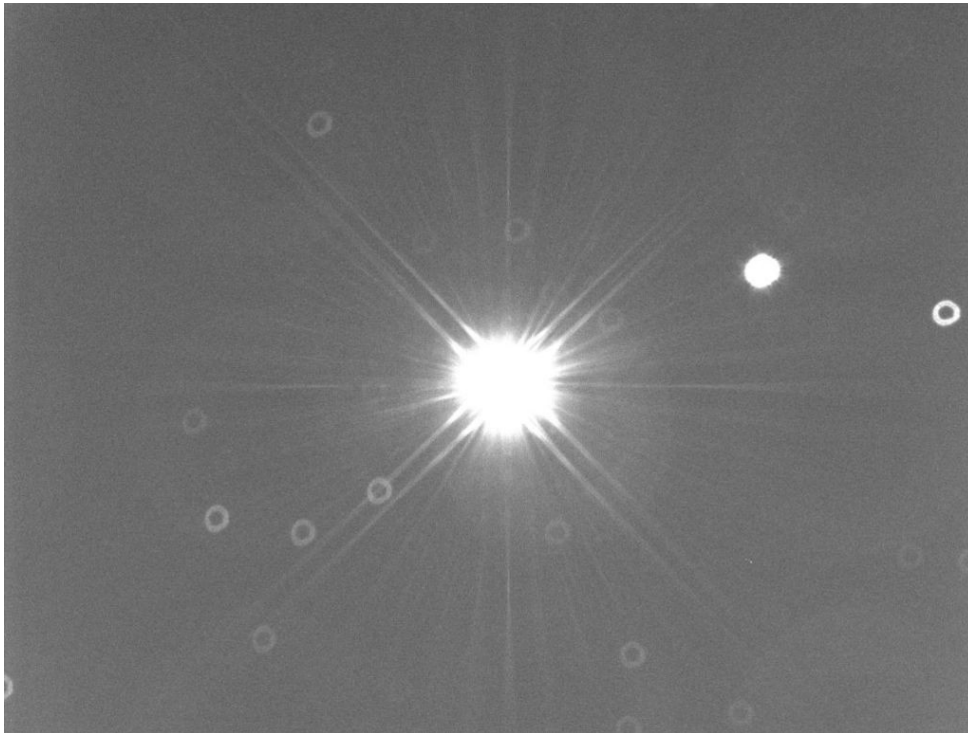
- Tighten the mirror towards the brightest side of the star,
- Alternatively, loosen the opposite side, depending on what collimation screws exist on your telescope.
- Recenter the star after each adjustment.

Result:

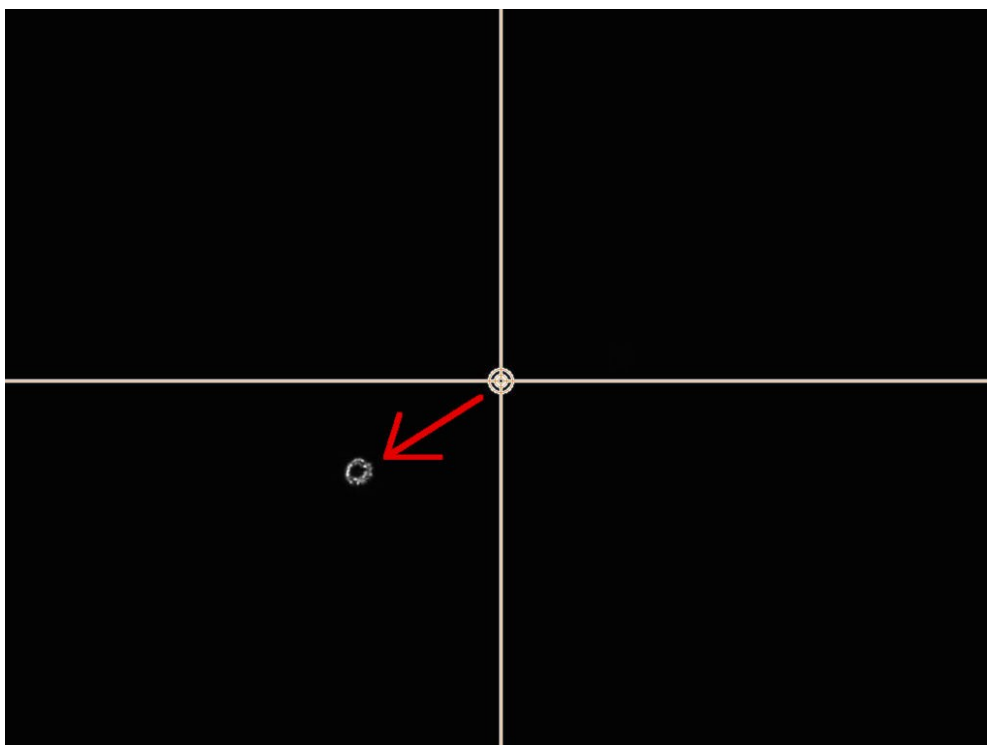


Better, but far from perfect.

Once you achieve the best you can, and that may not very good at the start of this process, especially if the seeing is poor, take a long exposure (e.g. 20 seconds) of the star field and stretch the image. It might be beneficial to refocus slightly to see the imperfections in the star shapes better.



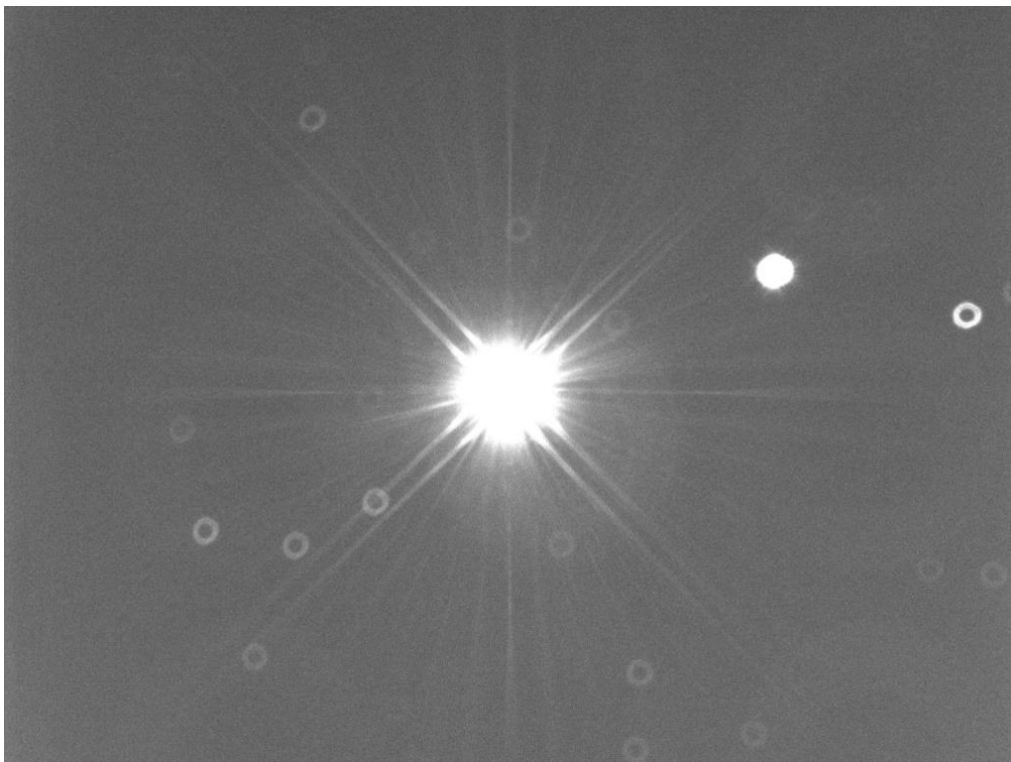
The best stars appear to be in the top right corner of the frame. The next step will therefore be to move the center star toward the bottom left using the secondary mirror (aka move the nicer stars toward the center of the frame).



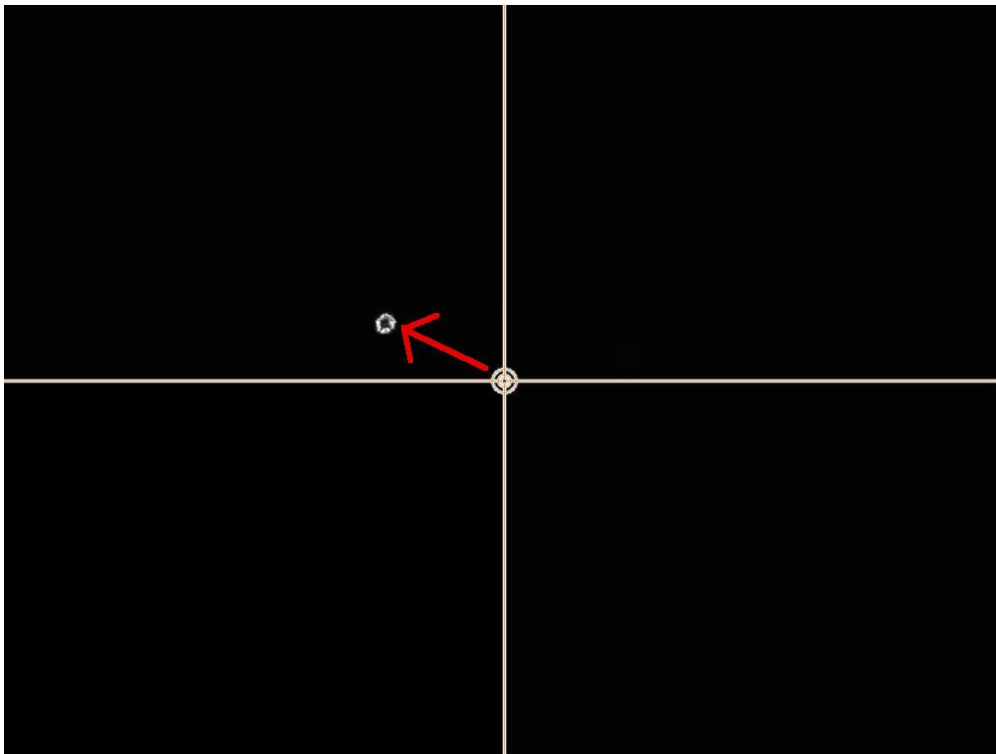
Move the star back to the center of the frame using the telescope coordinates controls and adjust the shape using the primary mirror collimation screws following the DSI method. Don't stretch the image and remember to recenter the star after each adjustment.



Refocus slightly, take a long exposure of the field again, and stretch.

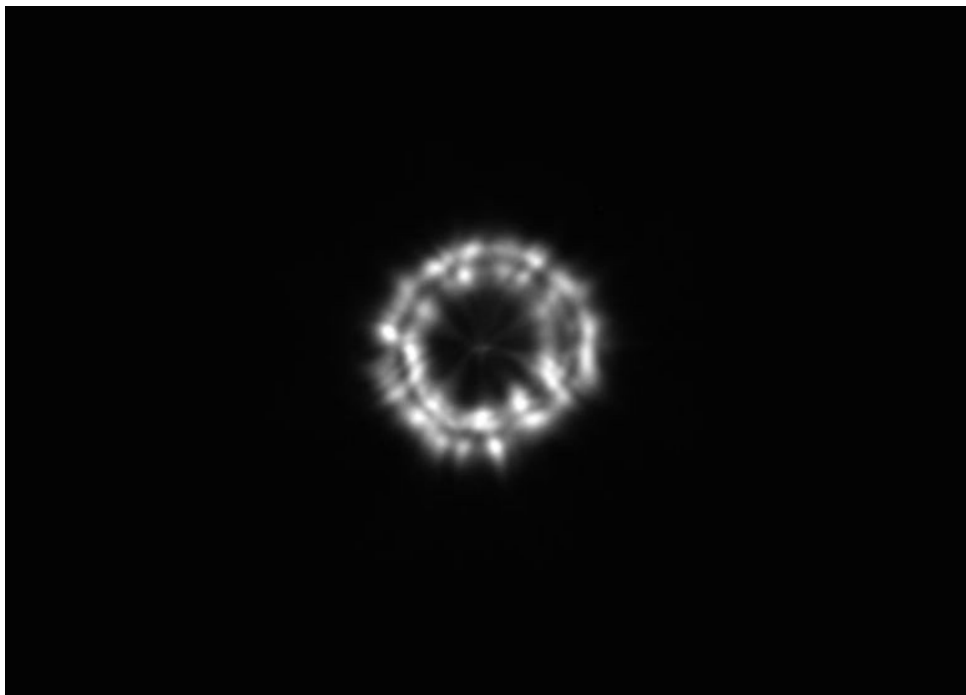


The last movement wasn't entirely successful. The movement down wasn't necessary. We therefore move the center star up this time. The best stars are in the lower right quadrant so we'll also move left. Defocus again and move the star using the secondary mirror screws.

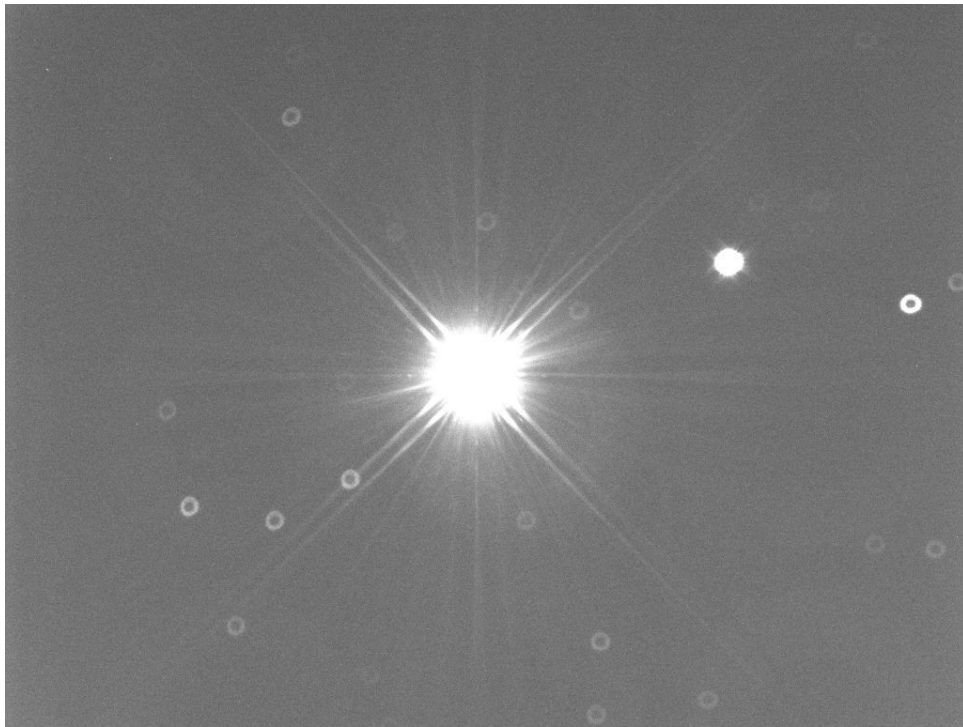


Move the star back into the center of the frame using the telescope controls.

Using the primary mirror collimation screws, fix the shape of the star.

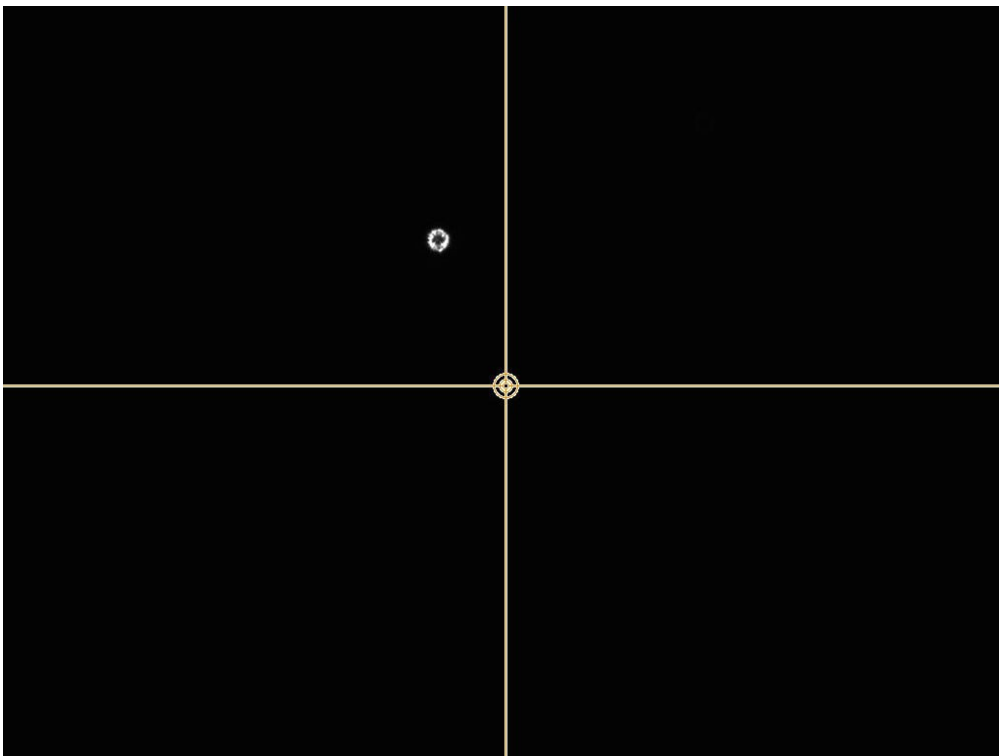


Refocus slightly and take a long exposure of the field.



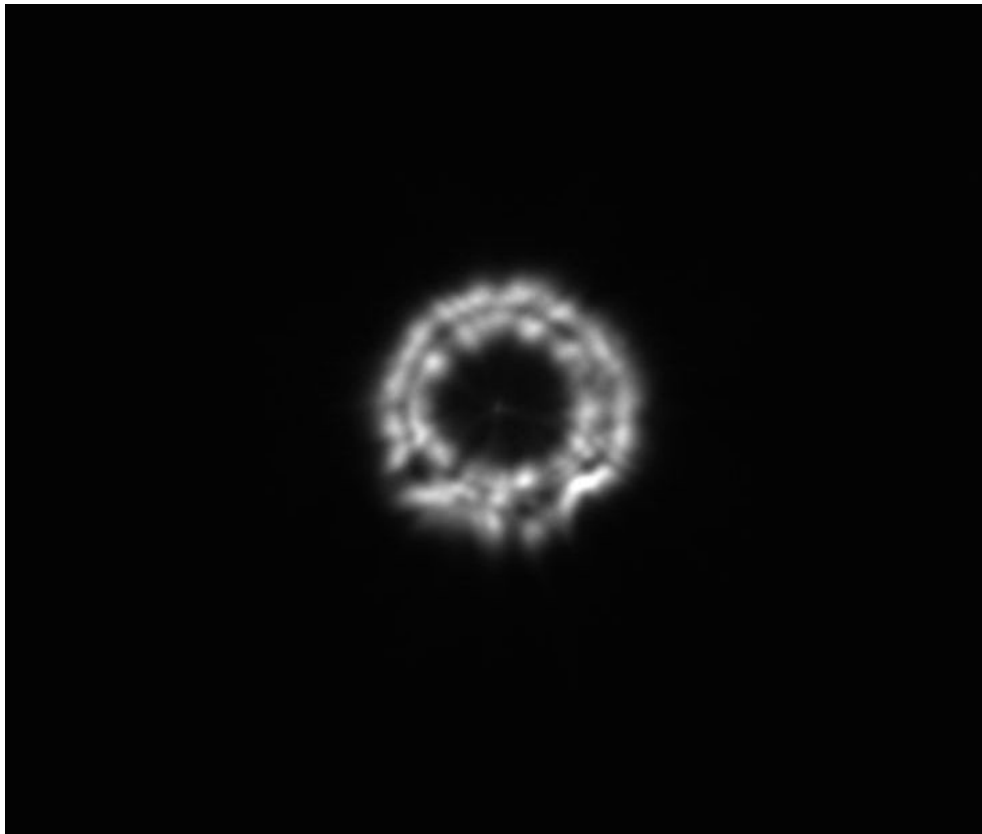
The roundest stars are still in the bottom right quadrant. We will therefore move the center star up and slightly left using the secondary mirror collimation screws after we defocus again.

As you progress in the collimation process, your movements will become smaller and smaller.



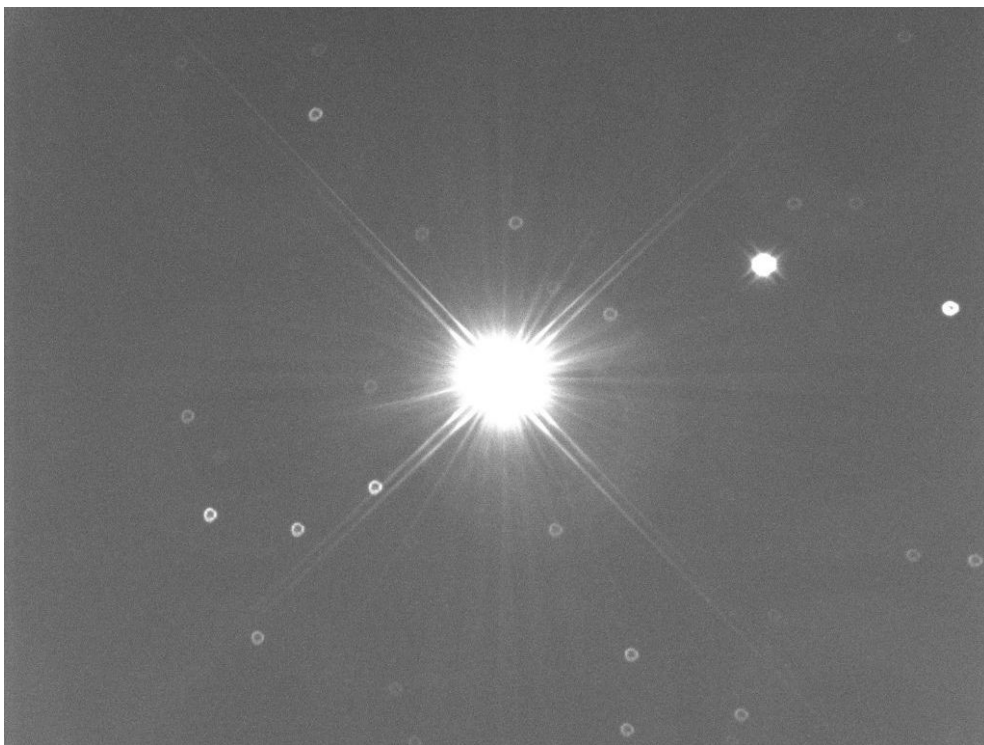
Recenter the star using the telescope coordinates controls.

Adjust the shape using the primary mirror collimation screws.

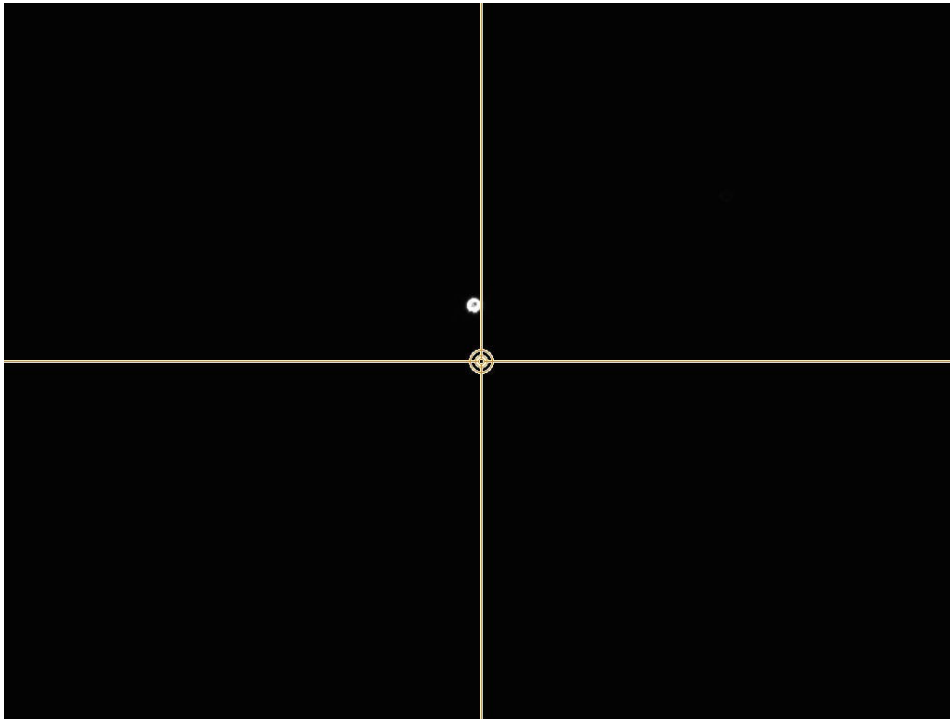


The center star is becoming rounder and we can see more details.

Take a long exposure of the star field and inspect star shapes.

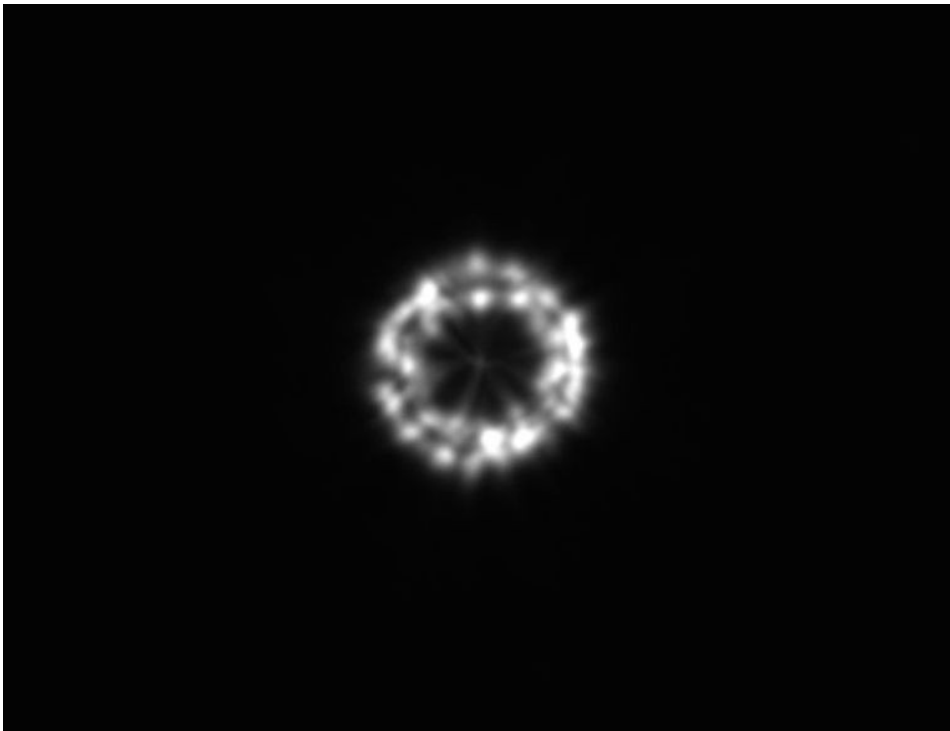


The roundest stars are still in the bottom part of the frame, but no longer toward the right. So we'll move the center star upward using the secondary mirror collimation screws.

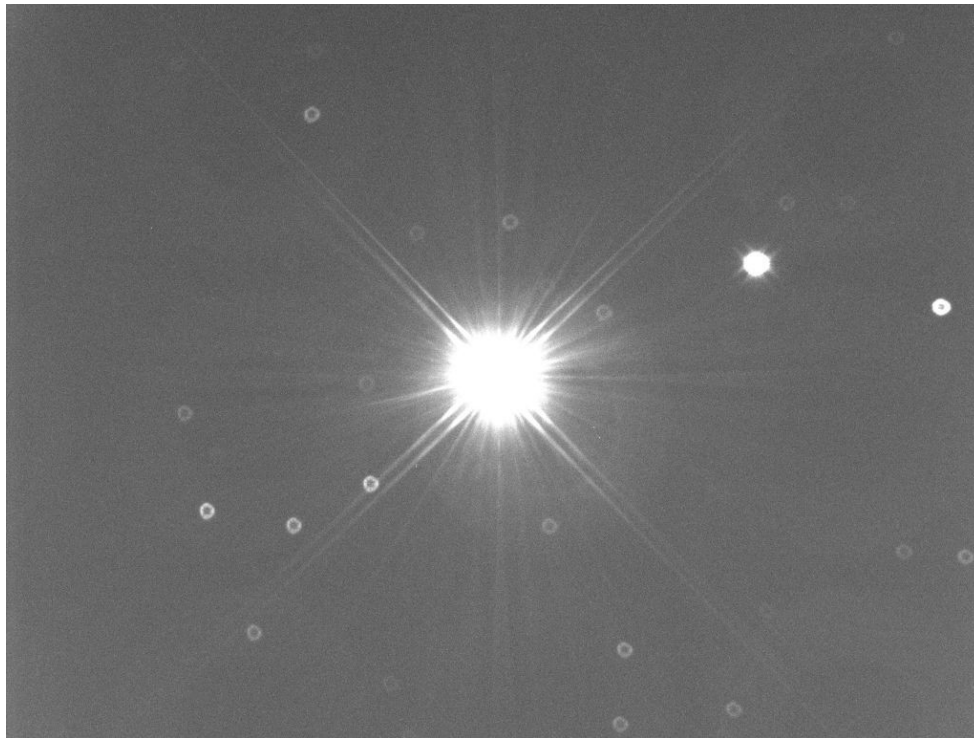


Recenter the star using telescope coordinates controls and start short exposures.

Adjust the shape of the star using the primary mirror collimation screws following the DSI method.

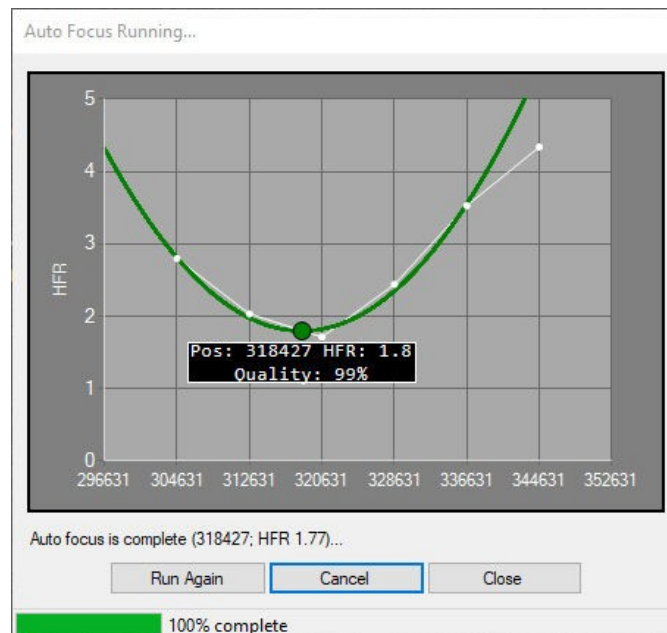


Refocus slightly and take a long exposure of the star field.



By now the process should be clear. Continue alternating moving the center star using the secondary, adjusting its shape using the primary, until you can't improve the shape of the stars anymore. As you get a better image, move toward the focus point more and more to see the defects in the stars better.

Finally, focus (or autofocus if you can) and measure the HFR of the star field. It should have improved compared to your starting point.



4. Acknowledgement

Thanks to Przemek Majewski for guiding me from “crap land” when my collimation was 1.5 frame out of the view of my camera and showing me the process.