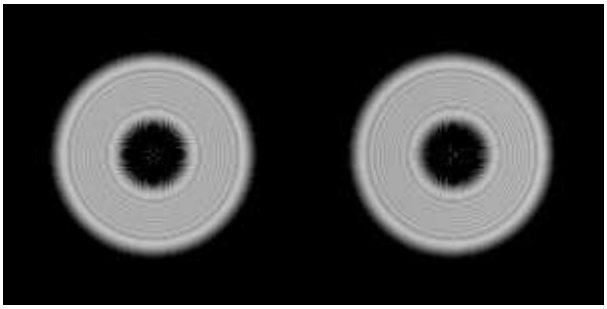
Star Collimation

STEP 1: *Rough Alignment*

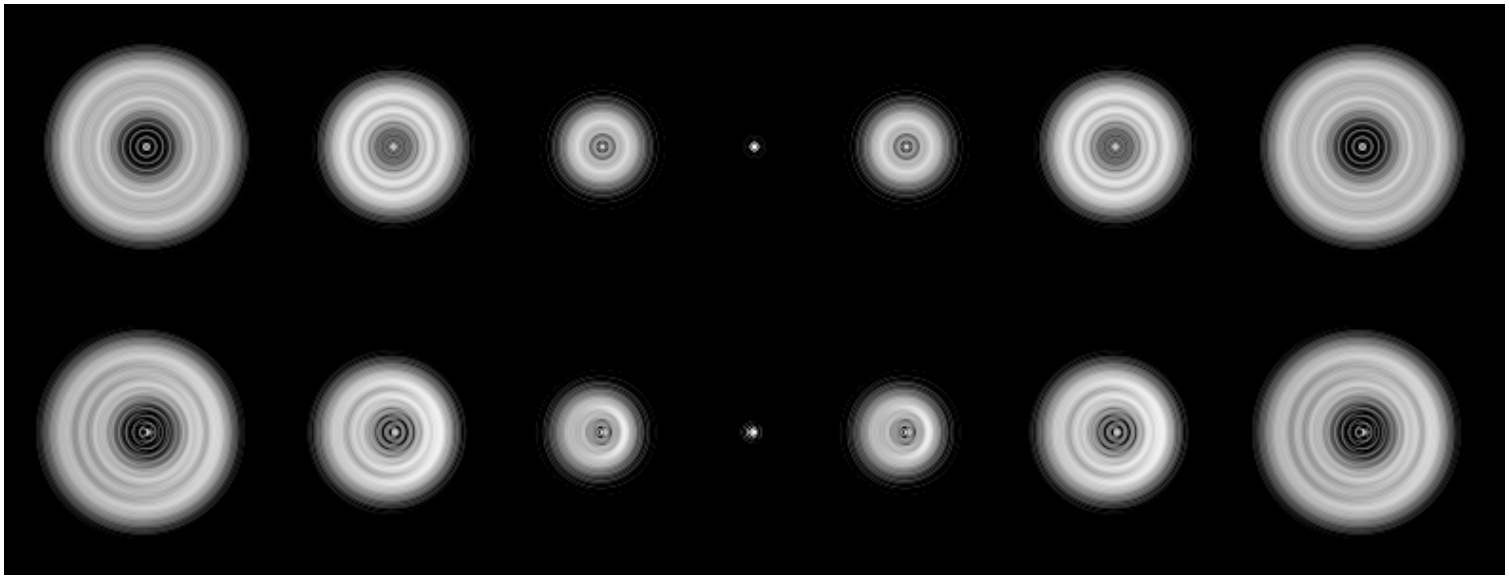
1. Observe a bright star (magnitude 0 or 1) at a magnification of about the diameter of the telescope in millimeters. (i.e. 300x for a 300 mm)
2. Defocus the star until it appears as a donut like the photo below. The central hole is the shadow of the secondary mirror.
3. This shadow must be perfectly centered (left figure). If it is shifted (right figure), adjust your secondary mirror to center in the shadow. If your arm is long enough, you can also put a finger in front of the aperture of the telescope and see the position where it corresponds to the shift.



STEP 2: *Intra and Extra Focal Alignment*

1. Observe a dimmer star (magnitude 2 to 3) high above the horizon to minimize the effects of the atmospheric turbulence, and a higher magnification: 2 to 3 times the diameter of the telescope in mm (ex.: 500x for 200 mm).
2. Do not hesitate to enlarge the image as much as possible, collimation defects are better visible. The star is slightly defocused back and forth (intra-focal and extra-focal patterns).
3. A complex system of rings and central bright point appear (figures below).This system must open and close itself in a perfectly concentric and symmetrical manner and the bright point must be at the center of the rings (upper series). If it is not the case (lower series), the screws situated on the side of the asymmetry must be adjusted, like at the first step.

Intra-Focal ***Focus*** ***Extra-Focal***



Note: The misalignment presented above would not have been visible at the first step

STEP 3: *Focusing Alignment*

1. Carefully focus the star from STEP 2 setting.

   Note: This last step needs good conditions of turbulence. If no Airy pattern (figures below) can be discerned, no high resolution result can be expected.

2. The famous Airy pattern appears: a false disk surrounded by diffraction rings of decreasing brightness (figures below). If collimation is good (figure A), the first diffraction ring around the disk is complete and uniform. If this ring is not uniform (figure B), or if it is incomplete (figures C and D), you must adjust very slightly the collimation screws as in the previous steps.

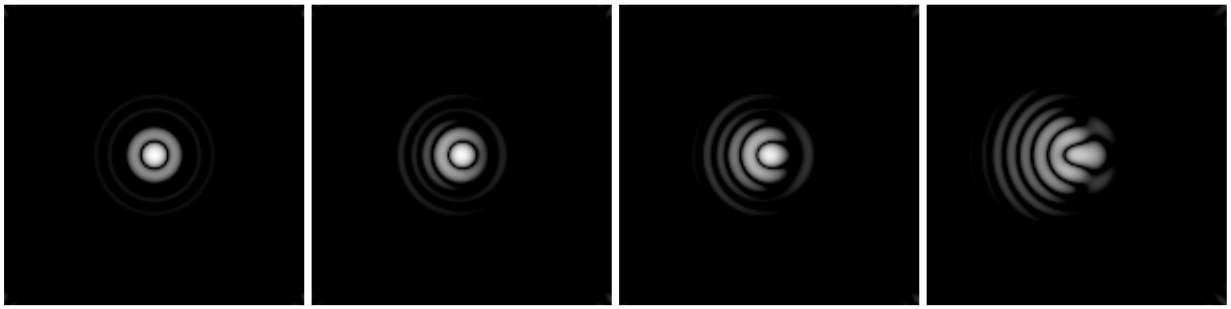
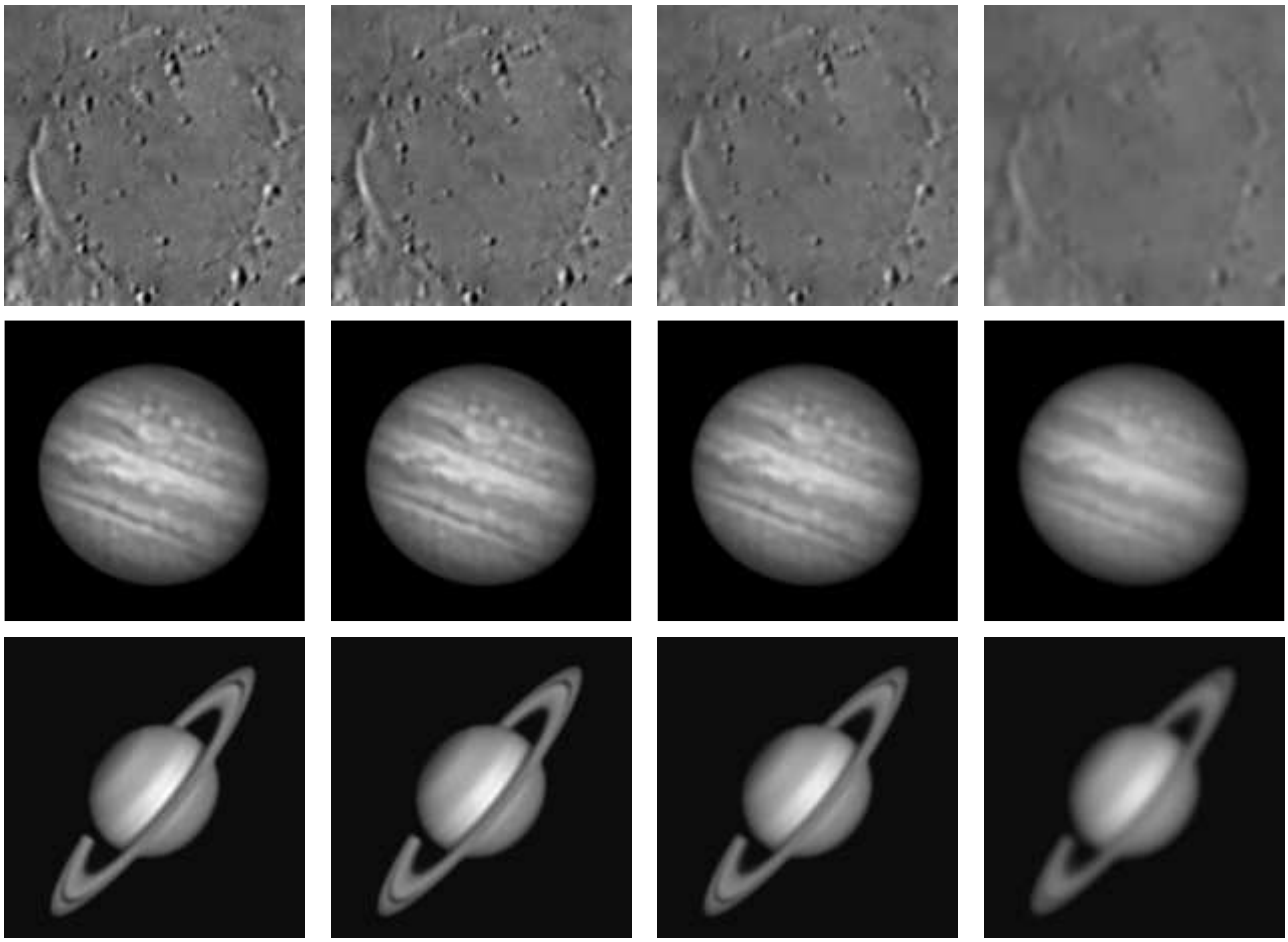


Fig. A Fig. B Fig. C Fig. D

From one figure to the next, the angle of misalignment of the mirror has been doubled. The worst misalignment (fig. D) represents only a fraction of turn of a collimation screw of a SCT. On this type of instrument, the transition from fig. A to fig. B represents less than 1/20th of a turn, a modification of the orientation of the optical tube can be sufficient to produce this effect. It is evident that the precision of alignment increases with each step.

Below MTF curve photos simulate the effect of misalignment on real image. Each Airy pattern corresponding to a given misalignment simulates the image that the telescope would have shown if it were affected by such a defect.



Courtesy photos and information by “The Collimation” - Tierry Legault.