

Mitsuboshi Knife-Edge Focusing

The Mitsuboshi knife-edge focuser is a precision focusing aid for astrophotographic applications. This consists of a metal-on-glass circular aperture held in an aluminum holder with C-mount threads, plus a C-to-camera mount adapter which allows the focuser to be used with virtually any type of common 35mm camera. Other adapters allow the knife-edge focuser to be used with Mitsuboshi vacuum-back astrocameras or Pentax 67/6X7/67II camera bodies.

The basic concept of the Mitsuboshi focuser is that it temporarily replaces your camera back for focusing. Thus focusing is accomplished looking through all optics that the film will be seeing. Critical to this is assuring that the film and focuser aperture planes are exactly matched. To assure this, your camera body can be sent to Hutech at the time of purchase of a focuser. The camera flange to film plane distance will be measured and the focuser calibrated to match. Alternatively, with the right tools, this can be done by you

as described in the separate Hutech document, **Mitsuboshi Knife-Edge Focuser Calibration**.

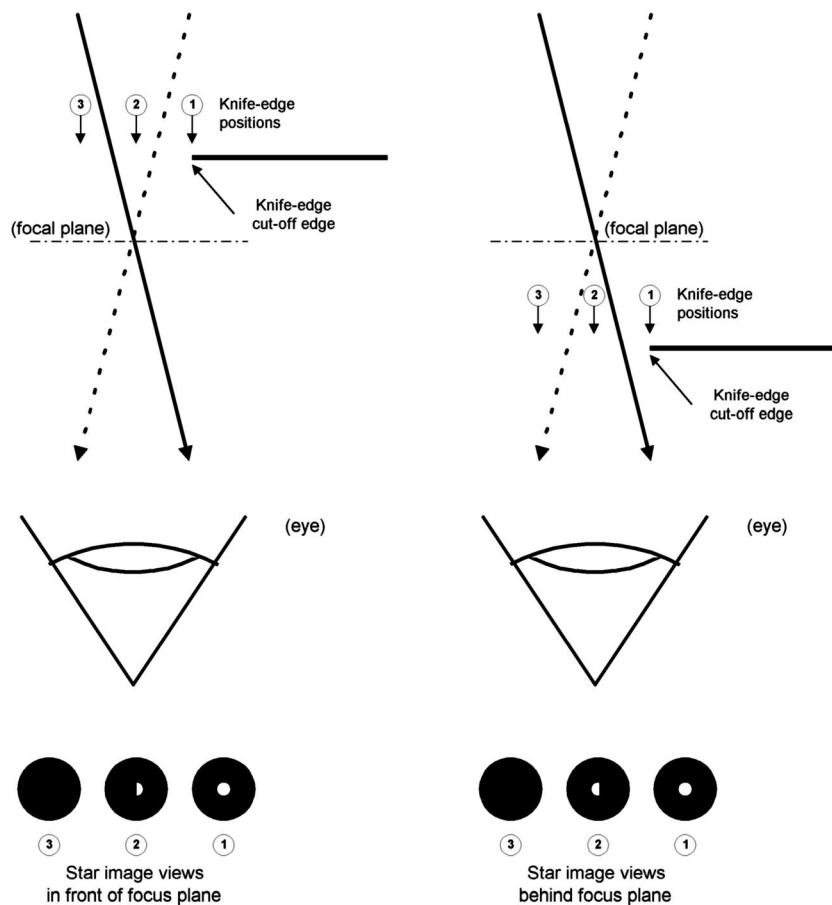


Focusing Operation

To use the Mitsuboshi focuser, first center your camera/scope combination on a relatively bright star. If possible, this should be near your target, but high enough in the sky to minimize atmospheric turbulence. All filters and optics to be used with the camera should be in place. However, if this makes it impossible to see a star for focusing, dense filters may be substituted with clear filters of the same thickness. If the camera has a viewfinder, use it to achieve approximate focus. This will speed up the focusing process.

Next, remove the camera body and mount the Mitsuboshi focuser in its place. Look into the focuser and note that the star appears as an out-of-focus circle of light. If you wear glasses, note that you do not have to wear your glasses for the knife-edge focusing step since you will be looking at an out-of-focus image of the star anyway. Now, using the telescope's slewing controls, move the star's image until it just disappears behind the edge of the aperture in the Mitsuboshi focuser, then move it just back into view for the critical focusing stage.

A schematic view of the knife-edge focusing setup is shown below, with the knife-edge and star image positioned for critical focusing.



On the left side of the diagram, the knife-edge is shown in front (toward the objective) of the actual focal plane. As the knife-edge is moved relative to the star's image (using the telescope's drive controls or by nudging the scope) from position 1 to 3, the image seen by the eye is shown at the bottom. The right side of the diagram illustrates the situation in which the knife-edge is behind the focus plane. Note that the direction from which the knife-edge shadow cuts into the star's image changes depending on whether the knife-edge is in front of, or behind the focus plane.

While coarse focusing, you may find it most efficient to use rapid slewing to move the star past the knife-edge to save time. As you approach the focus point, switch to a slower slewing speed as the star will extinguish more suddenly. To check final focus, simply nudging the scope a bit should be sufficient to move the star behind the knife-edge. When locking your focuser in place, some focus shift may occur, so rechecking the focus after locking is advisable. If your focuser locks with two screws, focus shift can be minimized by carefully tightening both screws simultaneously.

In theory, if the knife-edge is positioned exactly at the focus plane, when the edge cuts the light rays from the star, the image of the star disappears instantaneously, with no visible movement of the edge from any direction. However, with real-world optics and atmospheric turbulence, the exact cutoff point cannot always be easily determined. In this case, make repeated attempts to estimate the focal point, noting the position of the focuser (an indexed focuser such as a Borg helical focuser is useful here) each time, then taking the most consistent set of results. Alternatively, the just-ahead-of-focus point and the just-behind-focus point can be repeatedly determined and the exact focus point interpolated.

Note that the steeply converging light cone of a fast f-ratio system will show the focus point most distinctly, while a slow f-ratio system may seem to have an indistinct focus point, indicating its larger depth of focus tolerance.

Troubleshooting Focus Problems

While the Mitsuboshi knife-edge focuser will assure you of the most consistent possible focusing, you may still note out-of-focus stars in your images in some situations:

- ◆ Uniformly out of focus – In this case the focuser may not be properly calibrated for your camera body and film configuration. If you are using a single focuser for several camera bodies and/or films, you may require a separate focuser for each combination or you may find acceptable operation by adjusting the focuser to a compromise position. Refer to the Hutech document **Mitsuboshi Knife-Edge Focuser Calibration** for more details.
- ◆ Stars out of focus in outer parts of the frame – In this case, you may have an optical system which has a curved focal plane. Correct this by using a field flattener, or adjust the focuser calibration to offset the focus position (see **Mitsuboshi Knife-Edge Focuser Calibration**) so that the focus error is minimized across the film frame.
- ◆ Stars inconsistently out of focus in parts of the frame – In this case, your film may not be held flat enough. Sometimes this can be corrected by applying more tension to the supply and takeup reels, by skipping frames between shots, by adjusting the pressure plate spring tension, or by supplying desiccated air to the camera (humidity can cause curling of film). The best solution for this problem is to use an astrocamera with a vacuum back.