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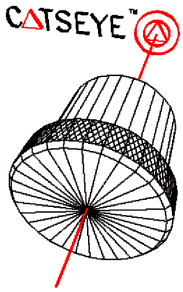

THE *CATSEYE™* NEWTONIAN TELESCOPE COLLIMATION PROCEDURE

Revised 09/17/2022

Before the *CATSEYE™* Collimation System can be effectively used, it is necessary that several preliminary mechanical alignments are verified and that the Primary mirror has been center-spotted with the self-adhesive reflective triangle. If you are collimating a commercial scope skip the first section

Initial Mechanical Alignments

- **The focuser should be "square" to the tube axis** If focuser "squareness" is in doubt, remove the diagonal/holder assembly from the spider and then remove the focuser and any accessories attached to the scope directly behind it and within 12" to the rear. For most focusers, the mounting holes are symmetric about the focuser axis and form a rectangle or square. Draw light lines with a pencil on the tube connecting the focuser mounting holes. Then measure and mark a point at the center of each side of the drawn rectangle. Cut a 12" wide piece of poster board a little longer than the circumference of the tube. Wrap it tightly around the tube until the ends overlap and the machine-cut edge is flush with itself and mark the overlap point. Lay the posterboard out flat; mark a point halfway between the overlap mark and the end to indicate the "half" circumference distance around the tube. Re-wrap the posterboard tightly around the scope with the machine-cut edge again along one of the two rectangle sides going around the tube. Rotate the posterboard strip to position the "half" distance mark over the rectangle side center mark and while holding this position, draw a short arc on the opposite side of the tube along the posterboard edge; then mark the location of the overlap "half-distance" point on the arc. Move the posterboard over to the other rectangle side going around the tube and draw a second arc and "half-distance" point. Now draw a straight line on the tube between the two "half-distance" points. Measure and mark the center of this line between the arcs - **THIS POINT SHOULD BE THE PROJECTED FOCUSER AXIS INTERSECTION ON THE OPPOSITE SIDE OF THE TUBE.** Verify this axial position by aligning the machine-cut edge of the wrapped posterboard with the 2 center marks on the drawn rectangle sides **parallel** to the tube axis and insure the machine-cut edge on the opposite side intersects the focuser axial intersection point you marked. Once confirmed, drill a 1/16" small hole through the tube. Remount the focuser and insert a "crosshair" sight tube such as the 2" ***TELETUBE XL/XLS™*** or ***TELECAT XL/XLS™***. Shine a bright light behind the tube through the hole and check for alignment of the sight tube crosshairs intersection over the hole. If necessary, adjust the focuser base tilt via height adjustment screws (if available on the focuser base) or shims under the base corners at the attachment bolts.
- **The Primary mirror should be centered on the tube axis:** If possible, measure the distance from the primary mirror edge to the inside of the tube (or mirror box in a truss style) at 4 places at 90 degree intervals to determine if the Primary is reasonably centered on the tube axis; adjust as needed if lateral adjustment method is available.

- **The diagonal should be centered on the tube axis (In larger scopes, a slight "vertical" offset may be advisable - see *TELECAT /TELETUBE XL/XLS™* instructions):** Measure the distance from the diagonal holder to the inside of the tube along each spider vane and adjust the spider attachment screws as necessary to position the diagonal holder in the center of the scope tube.
- **The diagonal should be centered under the focuser along the tube axis** - To aid in discerning the real edge of the diagonal/holder, lay a blank white piece of paper against the tube wall opposite the focuser. Loosen the diagonal/spider attachment. While looking through the empty focuser, rotate the diagonal holder in the spider mount until the periphery of the mirror appears as close to a circle as possible. Now, adjust the diagonal holder along the tube axis until it centered under the focuser. When the diagonal is properly positioned, there should be a uniform semicircle of white (the background paper) surrounding the end of the diagonal towards the primary mirror. Fine tune the diagonal rotation and axial position using a sight tube such as the 2" *TELETUBE XL/XLS™* or *TELECAT XL/XLS™*, by setting the sight tube depth in the focuser to just outline the periphery of the diagonal edge circular projection.
- **The Secondary diagonal tilt should be adjusted to center the reflection of the primary in the diagonal** - Adjust the diagonal holder collimation screws until the perimeter of the primary can be equally seen in the diagonal reflection. Ignore the secondary holder/spider vane reflections which will probably be skewed (this will be corrected with the Primary collimation below). If a sight tube is available and the primary is center-spotted, adjust the diagonal tilt until the image of the center-spot on the primary falls beneath the crosshair intersection.

Using the *MINICAT™* , *CATSEYE™*, *BLACKCAT XL™* , or *TELECAT ™* Cheshire Eyepiece to adjust the Primary Mirror

- The Primary mirror must be spotted with the *CATSEYE™* Self-Adhesive Reflective Triangle or "HotSpot" using the center-spotting procedure and Primary spotting template.
- For initial familiarization with the images seen with the *MINICAT™/CATSEYE™/BLACKCAT XL™/TELECAT ™* eyepiece, collimation is best performed out-of-doors with the scope aimed at the horizon sky away from the sun or indoors with the scope aimed a brightly-lit wall.
- For nighttime use, shine a bright LED flashlight from the FRONT END of the scope DIRECTLY toward the Primary center spot. Hold the flashlight next to the diagonal holder as close to the center of the tube as possible. (A convenient "spider" clip can be easily fashioned from a "chip clip" to hold the flashlight in position for "hands-free" collimation.)
- With sufficient light aimed at the primary, both the reflective ring of the *MINICAT™/CATSEYE™/BLACKCAT XL™/TELECAT ™* and the *CATSEYE™* center spot should be visible looking through the *MINICAT™/CATSEYE™/BLACKCAT XL™/TELECAT XL™* Cheshire eyepiece.
- If careful spotting-template orientation was followed ("Primary Center-Spotting Procedure"), the points of the *CATSEYE™* triangle center spot (or segments of the "HotSpot") will be oriented with the 3 adjustment screws of the primary mirror cell. Turn one of the Primary Cell adjustment screws and note the direction of movement of the triangle image relative to the *MINICAT™/CATSEYE™/BLACKCAT XL™/TELECAT ™* ring image. Likewise, turn a second Cell adjustment screw and note the relative movement. By correlating each adjustment with the resulting view obtained with the *MINICAT™/CATSEYE™/BLACKCAT XL™/TELECAT ™* Cheshire, you will quickly learn the visual cues to know the required screw to turn and its turn direction to bring the

triangle image inside the ***MINICAT™/CATSEYE™/BLACKCAT XL™/TELECAT XL™*** reflective circle image.

- You will find that actually **you only need to turn any 2 of the 3 adjustment screws** to precisely center the triangle inside the annulus of the ***MINICAT™/CATSEYE™/BLACKCAT XL™/TELECAT XL™*** reflective ring image. When the primary is collimated, the points of the triangle should just touch the inside circumference of the ring image; likewise, there should be an equal-sized dark gap between the sides of the triangle and the inside of the ring image.

Implementing Vic Menard's "Carefully De-collimated Primary" Protocol

- Start with the scope "closely" collimated -- good diagonal positioning and final Cheshire collimation.
- Carefully "de-collimate" the primary mirror only. I suggest the topmost collimation screw or whichever screw allows the primary mirror to gently "tip" forward (or backward -- direction isn't important.) The reason I suggest simple tipping motion is to minimize twisting in a sling or other edge support, which may not be as easily "undone" when the primary is re-collimated Perform this de-collimation with the autocollimator in the focuser to ensure that, as the "ghost" reflections are spread apart, they do not leave the face of the autocollimator.
- Looking in the autocollimator, you will notice that the primary mirror center spot is slightly offset (because the primary mirror has been de-collimated.) On either side of the primary mirror spot, you will observe a bright upright reflection and a slightly dimmer inverted reflection --flanking the primary mirror center spot. The separation between these 2 reflections, is 8X the actual primary mirror axial error (+/- any residual focuser axial error) induced when the primary mirror was de-collimated. For now, you can ignore the flanking reflections. Look carefully at the primary mirror center spot and you should be able to see a second, fainter, inverted reflection either behind or very close to the primary mirror center spot.
- Stack the faint, inverted reflection under the primary mirror center spot to form a "Star of David" by adjusting either the diagonal or focuser alignment ONLY. If the focuser is aligned instead of the diagonal, the impact on the primary mirror collimation will be minimized (not eliminated.) However, this is only an issue if the required correction is "significant".
- With the primary center spot and the faint inverted reflection precisely stacked, go back to the same primary mirror collimation screw you used to de-collimate the primary mirror and "undo" the de-collimation, watching in the autocollimator as reflections the intermediate reflection slowly merge with the primary mirror center spot and finally all secondary reflections finally disappear from view.
- Verify the primary mirror collimation with a calibrated Cheshire. If it agrees with the autocollimator -- you're done. If there is a slight primary mirror axial correction needed, make the correction and reiterate the autocollimator procedure. Now "axial" collimation is fully corrected and you can reevaluate the diagonal positioning if necessary.

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Compliments of Vic Menard

ENJOY EASY, PRECISION COLLIMATION!