*A publication from the Yahoo Group - WarpsCorp. Providing solutions to problems, answers to questions and ideas to share among the amateur astro community. We welcome you at:*
**http://groups.yahoo.com/group/WarpsCorp/**

# OPTIMIZING YOUR LXD55 SN REFLECTOR & AR REFRACTOR

**MODS & ENHANCEMENTS** **ULTIMATE COLLIMATION** **VOLUME 2**

***This guide represents the work and ideas of members of the Yahoo User's Group: "LXD55Telescopes" and WarpsCorp. More information can be had by becoming a member and active participant of these groups. All ideas, comments and questions are welcome and hopefully you will find it an abundant resource for ideas and answers to your questions.***

***The ideas and procedures contained within have been implemented and tried by users of the group and submitted in good faith in an attempt to maximize your enjoyment of your LXD55 Telescope.***

***All modifications and enhancements are done at the risk of the owner.***

***Having said this, please feel free to discuss and seek further information within the group.***

## *Collimation...*

Regardless of which scope you own, if the optics are not aligned properly (collimated) your fancy expensive eyepieces, tracking mounts and computerized locator will not do you much good. If the lenses and / or mirrors are not properly aligned, you simply will not be able to achieve the best views your scope can offer. That is why I consider this to be the starting point of setting up your scope. The following is the procedure I follow whenever I set up a scope for the first time. I refer to it (tongue in cheek) as the Ultimate Collimation. This is a one time procedure which should not have to be repeated in its entirety unless you change focusers, remove elements of the optical path or suspect that the scope has suffered severe trauma. Once you complete this process, only minor tweaks and adjustments will be needed as you pursue those elusive fuzzies and search out lunar and planetary detail.

You will need some basic tools. These are all available from better dealers across the country.

*Note: The products mentioned are ones which myself or other users have had personal experience with. This does not represent an endorsement of any particular product or dealer. The prices are for reference only as this is what I found available.*

There are those that will say all you need is a film cannister with a sight hole - and for them that may work. However, after investing several hundreds or even thousands of dollars in a nice scope - the prices these tools cost are insignificant if it means improving the views.

For a Newtonian type reflector, I recommend a Laser/Cheshire combination ($79.00), Cheshire / cross-hair sight tube ($25.0 and as an option, a auto-collimator eyepiece ($29.00).

**http://www.telescope.com**

**http://www.amateurastronomy.com/tools.html**

I also own a Cats-Eye Collimation tool which is very easy to use and see. You can read more on it at:

**http://home.earthlink.net/~flyj/cecphome.html**

If you have a refractor, a Cheshire cross-hair sight tube and laser will also make this easier. A very nice economical Cheshire can be found at:

**www.scopestuff.com**

The auto-collimator looks like a simple eyepiece with a sight hole in the top. On the inside of the top, there is a precisely aligned circular mirror mounted to reflect light into the sight path. You can learn more about this device at:

**http://www.amateurastronomy.com/tools.html**

For those wanting to know more on collimation theory:

**http://www.efn.org/~mbartels/tm/collimat.html**
**http://www.astro-tom.com/telescopes/newtonian.htm**
**http://home.earthlink.net/~flyj/mccluneytext.html**

## *Newtonian (Reflector) Collimation...*

*Read The Entire Procedure Before You Begin. Entire Process Takes About Three Hours - But The Rewards Are Worth It - Sharper / Clearer Images.*

*Tip: Plan ahead. Since you will be disassembling the OTA, now is a good time to plan on any other accessories you may want to mount to the OTA, flocking the interior of the tube, adding a focuser, etc.*

What you need: laser collimator / Cheshire cross-hair sight tube / saran wrap / 1/16" drill / black fine tip marker / white construction paper / ruler / scotch tape / patience.

Optional: auto-collimator eyepiece / white cotton gloves / latex gloves / long nose forceps.

I normally wear white cotton gloves with disposable plastic gloves underneath whenever handling optics. The plastic prevents any oils from my skin being absorbed into the cotton.

*Before Removing The Primary Or The Secondary Cell / Corrector Plate Assembly, Mark Its Exact Position With Masking Tape So You Can Re-Install It In The Exact Position. Do This Now As Shown In The Picture.*

*Tip: Notice in the photo that the four stock socket head screws holding on the corrector have been replaced with standard socket head screws which are much less likely to strip. Pull one screw out and take it down to your local hardware store - get the same thread size but just slightly longer. Get a total of eight screws and eight matching washers - to take care of both the corrector and the primary cell. I usually mark the cell / OTA with tape in four places when removing them.*

**Step 1: Insure that your focuser is perpendicular to the Optical Axis of the OTA.**

Remove the Corrector Plate/Secondary assembly and the Primary cell by removing the allen head screws in the gray metal circular cell around the outside of the OTA. Do NOT remove the corrector lens from the circular gray metal cell. Remove the focuser and the finder scope mount from the OTA.

Take several sheets of white copy paper and tape securely together to form a piece long enough to wrap smoothly and tightly (no sags or gaps) around the inside of the OTA. Make sure one edge is straight and square. Align the front straight edge of the paper flush with the edge of the OTA. Make it a smooth tight fit and tape the ends to form a cylinder. With the paper in place, mark the positions of the screw holes for the focuser. Remove the cylinder, cut out the holes for the screws slightly larger than the nuts that hold it on (you need the paper to fit back in the tube as smoothly as possible once the focuser is reinstalled. Reinstall the focuser. Rack out the focuser so there is no intrusion into the OTA. Mount your laser in the focus tube. Make sure it is snug. You may have to shim it with a wrap or two of scotch tape. Once it is in the focuser, turn it and watch the dot on the opposite side of the tube. The dot should remain stationary. If it does not, either the laser within the collimator is not centered or the collimator itself is not centered in the focus tube. Rack the focuser in and out and watch for movement of the dot. Again, it should remain stationary. Adjusting the tension knob on the focuser may help this. If you can not get it to stay stationary, rack it all the way in and out and pick the mid point of movement (an average if you will). Leave or lock the focuser in this position.

Reinsert the paper cylinder carefully aligning it with the front edge of the OTA. Turn on the laser and from the inside of the OTA, mark the red dot on the paper with the black marker. Turn off the laser - do NOT remove it or move the focuser. Remove the paper cylinder and very carefully punch a clean 1/16" hole where you marked with the marker. Now flatten the cylinder so that the two long edges are aligned and the crease at one end is centered through the hole you just made. You now have a long rectangle with a hole punched in one of the creases. Take a ruler and measure along the crease EXACTLY how far from the long edge of the paper is to the hole. Transfer this measurement to the opposite end and mark the position on the that crease. Unfold the crease so you have a cylinder again and punch a 1/16" hole in this second mark you just made.

*Tip: Make this measurement and mark as precisely as possible as this will be the alignment target for your focuser.*

Reinsert the cylinder back into the OTA, line up the front edge with the OTA, turn on the laser and make slight adjustments to the position of the cylinder within the OTA until the beam shines through the first hole you punched.

The front edge of the paper should still be lined up with the edge of the OTA. If the beam is striking the second hole you punched - all is good - tighten down the focuser - evenly tightening all four screws so that ***the laser dot does not move off its target of the second hole. If it does not hit the "target", make adjustments to the four screws and shim the focuser with black construction paper or felt until it does. If your focuser has a collimatable base, use the screws provided for those adjustments. Carefully tighten everything down.***

Your focuser is now very, very close to perpendicular to the OTA optical axis. You can verify this with your cross-hair eyepiece if you have one. The cross-hairs should be on the mark on the opposite side of the tube. Once you are satisfied with your ***results - Go to the next step. Leave the laser or sight tube aligned (turned off) in the focuser.***

**Step 2: Aligning the secondary.**

Print out the "Secondary Target" templates which are posted in the files section and in this document. Very carefully cut one out and punch a small pin hole in the exact center (printed cross-hair intersection.)

Carefully wrap the saran wrap over the surface of the secondary. Pull it tight and tape it down to the sides of the secondary with scotch tape. I leave a folded over tab on each piece of scotch tape so that I can reach in through the focuser when finished and remove it with a pair of forceps. Carefully position the target template over the secondary and mark the exact center with black marker. Reinstall the corrector / secondary assembly aligning it with the marks you made previously so it is in its correct orientation.

*Tip: After you replace the corrector cell, carefully remove ONE of the three small socket collimating screws under the front cap. Do NOT touch the center screw at this time. Take the screw down to your local hardware and get three replacements of the same thread with larger heads. This will make future adjustments much easier in that you can use a larger Allen wrench and not have to worry about stripping out the socket on the soft stock screws.*

Turn on the laser or use your cross-hair eyepiece to verify that the mark you just made on the secondary is under the cross-hair or the laser dot. If it is not, adjust the secondary by loosening the allen screws holding the cell and moving the entire cell forward or backwards.

If there is not enough movement available for the cell, you may have to loosen the center screw under the pop off cap on the front of the corrector plate. The secondary is held in place in a "push-pull configuration where the center screw is pulling the secondary against the three outer adjustment screws. Careful - very fine - adjustments are needed - no big turns.

You always want to take up any "slack" and keep the secondary held tight. As you loosen the center screw - you must tighten the outer ones. If you loosen the outer ones - you must tighten the center. If you get too much slack, the secondary will become loose and could rotate relative to the corrector - this will add more adjustments to the alignment procedure. Never loosen more than one screw at a time as you don't want the secondary turning if you can help it.

Once you have the target centered, tighten everything up. Reach in with the forceps and very carefully grab the scotch tape tabs and pull them off - removing the saran wrap.

**Step 3: Aligning the primary.**

*Mark The Orientation Of The Primary Mirror Cell To The OTA With Masking Tape Strips As Described For The Front Corrector Cell.*

Carefully remove the four socket screws in the primary cell. These can be later replaced with the longer larger Allen head screws as we did with the front corrector cell.

Very carefully determine that the center mark on your primary is indeed the center of the mirror. There is a Mirror Template in the first Tips & Tricks Guide. You can print it out on a piece of clear transparency or regular paper. If it is not centered, you will either have to remove the existing ring and install your own, or leave it where it is. Pure filtered acetone applied with a Q-Tip to the paper ring will allow you to lift it with a pair of tweezers. Use clean cotton swabs to dab up excess glue and acetone. Do NOT smear it over the surface of the mirror. You can use a cloth loose-leaf reinforcement ring to replace the original donut. Use a permanent marker to color it black before applying.

What your level of tolerance is will be your own choosing.

Once you have determined that the center is marked correctly, then determine if the mirror is centered in the cell.

Carefully measure from the slot in the cell that the OTA slides into to the center of the mirror (or use the template for mirror spotting). If it is centered, you are set. If it is not, then we have more work to do.

*Make Sure You Have Marked The Orientation Of The Primary Mirror Position In The Cell Using Masking Tape As You Did With Corrector Cell And The Primary Cell.*

Carefully remove the 6 screws holding the mirror clips and remove the primary. NOTE: On the newer SN series of scopes, the primary is siliconed into the primary cell. This may prevent you from removing the primary mirror from the cell. If you do not feel comfortable removing the primary, thensimply verify the center mark is accurate.

*Remove The Primary Mirror And Sit It Aside In A Safe Place.*

Find the exact center of the empty mirror cell. You can measure with a ruler, use a compass, or the center spot template. Drill a 1/16" hole through the exact center of the cosmetic plastic disc attached to the cell. Remount the empty primary cell. Turn on the laser and adjust the secondary collimating screws (three small screws) until the laser exits through the 1/16" hole. Now the secondary to primary path is very closely aligned with the central optical axis of the OTA - this is a good thing.

Now remove the empty cell and remount the primary into the cell. Turn on the laser. If your primary is centered within the cell and if the center mark is accurate, the laser should be hitting the center of primary center spot donut. If it is not, you will have to "shim" / shift the primary within the cell until it does. Trial and error is the proven method here.

*Tip: Now is a good time to perform that clipectomy to remove those spike inducing mirror clips by siliconing the mirror to the primary cell. I used 9 globs of silicone, set the mirror in the cell, installed the clips using round toothpicks to "wedge" shim the mirror while the silicone was curing. Once you get the laser centered on your doughnut ring target - set the mirror aside and allow the silicone to cure for 24 hours.*

*You can read more on this procedure at Paul LeFevre"s web site:*

**www.lefevre.darkhorizons.org/lxd55/clipectomy.htm**

After 24 hours - reinstall the primary mirror cell. If all is good, when you turn the laser back on, the dot should be in the exact center of the mirror cell (assuming you have not had any major temperature swings during this process). I did mine in the basement where temperature and humidity is pretty much constant. Even if you have to make a slight tweak adjustment after final assembly - it is allot more accurate than when it arrived after careful handling by UPS.

*Tip:* If you look closely at the picture of my primary mirror cell, you *will notice that under each of the three large knurled collimating screws is a white nylon washer. These washers serve a dual purpose. They prevent the knob from scraping away at the paint of the primary cell and they make the adjustment "feel" of the knobs a lot smoother and easier. Again, your local hardware store should have these available.*

From this point on, after set up and temperature acclimation - a quick 1 minute laser alignment is all that is needed to get really sharp detailed views. Put the laser in the focuser, adjust the secondary screws till the beam is in the center of the donut, adjust the primary knobs till the beam reflects back up on itself. *This is where the Orion Deluxe Laser really makes this process easy. You can view the beam returning on itself while standing at the back of the scope and making the adjustments.* I finish using the lock down screws on the primary cell as my fine tune collimation screws after I get close with the big knobs.

A final test of how good your collimation is can be done with a device (EP) called the Auto-collimator. When it is inserted into the focus tube, if all is aligned perfectly, you will get a "closed" optical path. All you will see is a dark circle in the center of the secondary as it is the reflection of the dark of your eye's pupil.

The f/ratio will have no effect on this as you are not "projecting" any holograms. You are simply aligning the light path from your eye -> secondary -> primary ->secondary ->eye. Simple geometry and a few tweak adjustments.

After all is said and done, when you focus on a bright star with an ep of 12mm or higher power, you should be able to focus to a pinpoint, and then by racking in and out, the pinpoint should diffuse into a series of concentric circles on both sides of the focus point. If the circles are not concentric, then you need to tweak the primary just a bit. You can always go back to the laser to make sure the secondary is still in line with the focuser and the center dot on the primary.

## *Refractor Collimation...*

*Read The Entire Procedure Before You Begin. Entire Process Takes About One Hour - But The Rewards Are Worth It - Sharper / Clearer Images.*

While refractor telescope assemblies, in general are ususally less succeptable to collimation errors, there is still the possibility that your scope could be better fine tuned and thus give you better views.

**Step 1: Insure that your focuser is perpendicular to the Optical Axis of the OTA**

What you need: laser collimator or Cheshire crosshair sight tube / scotch tape / round toothpick / crosshair target / phillips screwdriver / patience.

The Meade AR-5 and AR-6 refractors do not have focus cell adjustment provisions - however, with patience, the correct alignment can still be accomplished.

Remove the OTA from the mount and lay it down on a padded level table so that you do not have to worry about it rolling around while making the adjustments. Remove the diagonal and install the 2' to 1.25" adapter in the end of the focuser. Position the OTA in front of you so that the focus cell is hanging out over the edge of the table (facing you).

Carefully remove the dew shield from the front of the scope and set it aside. Cut out the crossshair target at that end of this guide. Have someone shine a bright flashlight down the OTA from the focuser end.

*Tip: I simply insert a small pen light in the focuser and tighten down the retaining screw on the collar.*

Take the printed target and carefully punch a tiny hole at the exact center of the crosshairs with the toothpick. Carefully tape the target over the objective end of the OTA using the shadow cast by the flashlight to help you center the target over the objective. Once centered, secure the tape over the edges of the objective cell - do NOT let the tape touch the lens. Remove the flashlight.

Insert the laser or the crosshair Cheshire into the focuser and tighten it in place as you would the diagonal. The laser should exit through the small hole you punched in the target / or the cross hairs should be centered on the cross hairs of the target depending on which device you choose to use. If it is centered, your focuser is square with the objective and you can proceed to the next step - #2.

If it is not aligned, loosen the three screws of the collar of the focus cell. This should allow you "rock" or "wiggle" the entire focus cell - allowing you to move or adjust the cell moving the laser dot closer to the center target.

*Tip: If using a laser, placing a mirror in front of the scope will allow you to see the laser dot move on the target as you make adjustments to the focus cell.*

If the focus cell refuses to "rock", you may have to remove it to eliminate the sticky tape that Meade wrapped around the OTA between the tube and the cell. I had to use a rubber mallet and a small block of wood to give a few gentle but firm taps against the edge of the focus cell to get it to release.

One removed, clean off the stickey tape with alcohol or acetone. I then replaced it with a single layer of cloth electrical friction tape and re-installed the focus cell. Since the holes and screws in the cell or self centering, I used a fine bit in my dremel tool to very slightly elongate each of the three screw holes along the axis of the OTA.

*Note: If you are going to grind out the holes, it is absolutely imperative that you do NOT get any metal shavings up into the OTA. The easiest way to avoid this is to take a clean lint-free cloth and tightly stuff it into the end of the open OTA. When finished, hold the OTA with the open end pointed downward and carefully pull out the towel.*

It should now be easier to adjust the focus cell until the laser exits the hole in the target or the crosshairs of the Cheshire or centered on the target. Carefully tighten down the screws in such a manner that the laser or Cheshire maintains the alignment.

**Step 2: Collimating the front objective (AR6 only)**

Place the Cheshire sight tube in the focus tube and lock it in place. Looking through the peep hole of the Cheshire should shhow the crosshairs of the Cheshire lined up on the center of the cross hairs of the target. You may have to slightly adjust the Cheshire in the focus tube to make this alignment.

Shine a bright light into the window of the Cheshire - a goose neck high intensity desk lamp works well for this. Looking though the sight tube you will see three small illuminated circles - two are usually very visible with the third being very faint. These are the reflections of the metal Cheshire insert reflecting off the surfaces of the glass in the lens. All three circles should be centered on top of one another - centered on the target If this is the

case, You are finished with the front objective adjustments. If not - if you can see individual non-centered circles - you will have to adjust the front objective.

This is accomplished by utilizing the three pairs of "push-pull" screws around the outside of the objective. Each pair of screws consists of one "pull" screw which screws into the metal collar and actually holds the front lens cell in the mounting ring. The second screw of each pair is the "push" screw which pushes the lens cell out from the mounting ring allowing you to adjust the "tilt" of the lens cell so that it is perpendicular to the optical axis of the OTA.

By making fine adjustments to each of these pairs of screws, it should be possible to get all three of the reflected circles centered upon the center of the target.

Be patient, sometimes only very fine adjustments are needed. Once aligned, tighten the screws to "lock" the cell in place. Remove the Cheshire sight tube.

At this point, the front lens cell and focuser should be in alignmnet to each other and the OTA.

**Step 3: Aligning the diagonal**

Now that the focuser is squared and the front objective aligned, the final step is to ensure that when you insert the diagonal, it doen't undo what you just accomplished.

Mount the OTA back on your tripod /gem mount and put it in Polar Home position.

Insert the diagonal into the focuser and position it so it is pointing straight up relative to the OTA in it's mounted position. Tighten the knurled knob to hold it in place. Tighten the threaded collar on the focuser to keep the diagonal from rotating.

Insert the laser or Cheshire back into the diagonal and tighten it down as you would an eyepiece. Chances are the laser or crosshair will be slightly off-center of the target still taped over the objective. If it is centered - you are close enough. If not, continue on.

Most quality diagonals have four screws on the bottom holding the bottom and the mirror in the diagonal. These screws are ususally the self tapping type and are fairly tight within their threads. By very carefully and very slightly loosening or tightening these screws, you can adjust the angle of the mirror to recenter the laser or sight tube on the target. Very slight adjustments are needed as you do NOT want the screws to be loose.

Once centered, tighten the set screw holding the diagonal being careful to maintain the alignment. Slight adjustments to the four screws may need to be done again.

You should have a very close collimation which can be fine tuned with adjustments to the front using a star test AFTER the scope has equalized to the outside temperature.

*Tip: Once I have everything in alignment, I never loosen or remove the diagonal. I loosen the threaded collar on the focuser and rotate the entire focus tube to put the diagonal in a comfortable viewing angle as necessary. While this will indeed affect the alignment, I have found that the variance due to "play" in the threads is a lot less than that introduced by the re-positioning and rotating of the diagonal itself.*

**Examples of a good star test!**

Courtesy of: http://zebu.uoregon.edu/~mbartels/kolli/kolli.html

## *Put That Film Cannister To Use...*

Now that you don't need that old film cannister peep hole any more, let's put it to good use to keep excess moisture out of your OTA.

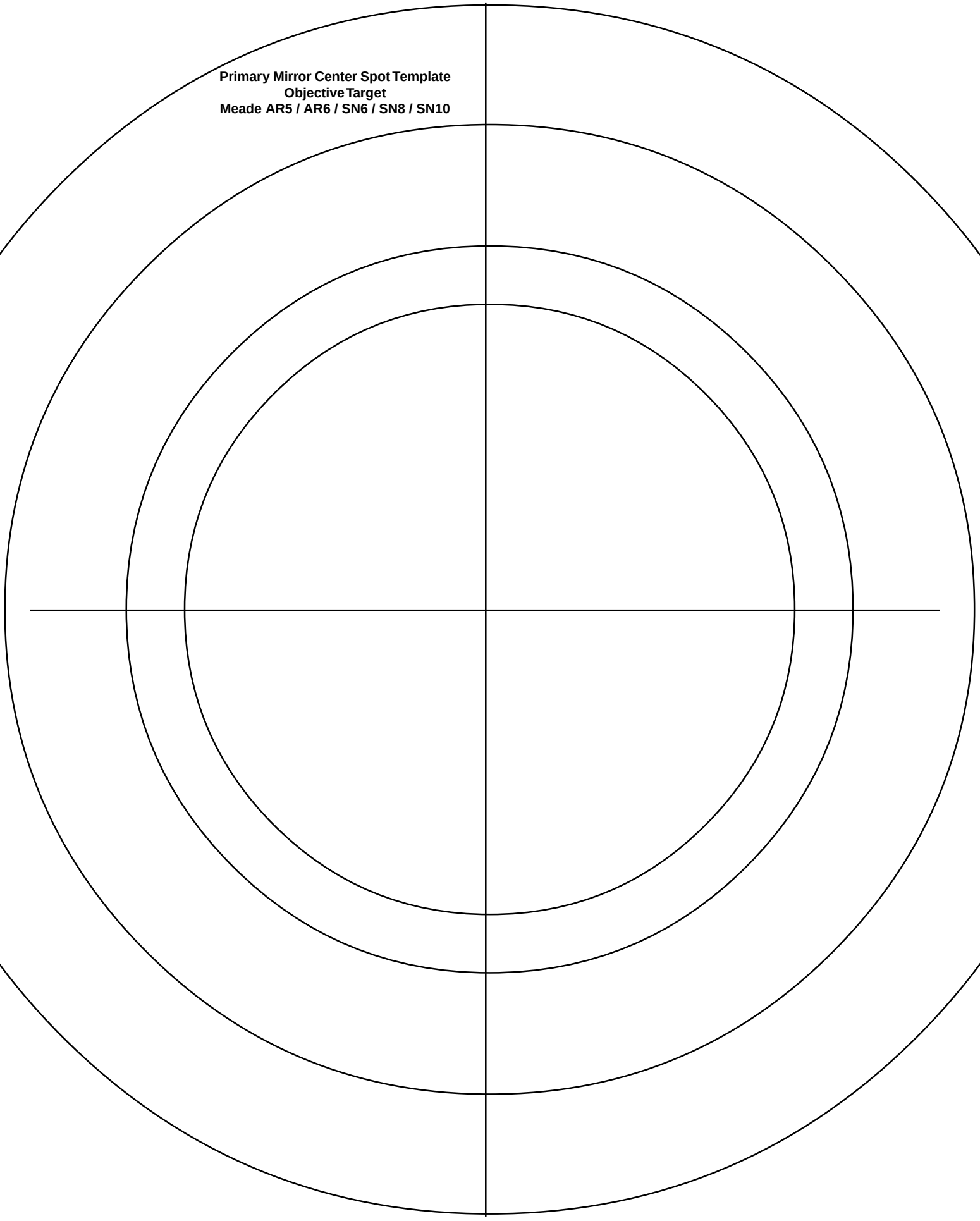
First, get a new lid, or a new cannister. Take a 1/8" drill and perforate the bottom and lower two-thirds of the canister. Call your local Walgreens Pharmacy and ask them to save you the sodium silicate dessicant packs that are packed with all of their prescription packages. I called two and in two days had a shoe box full of the pakets.

Cut the packets open and pour the contents out into a clean pyrex measuring bowl or cookie sheet. Bake in the oven for 1 hour at 450 degrees. Take out and let cool. After cooling, I poured them into a strainer and shook out any small particles or dust.

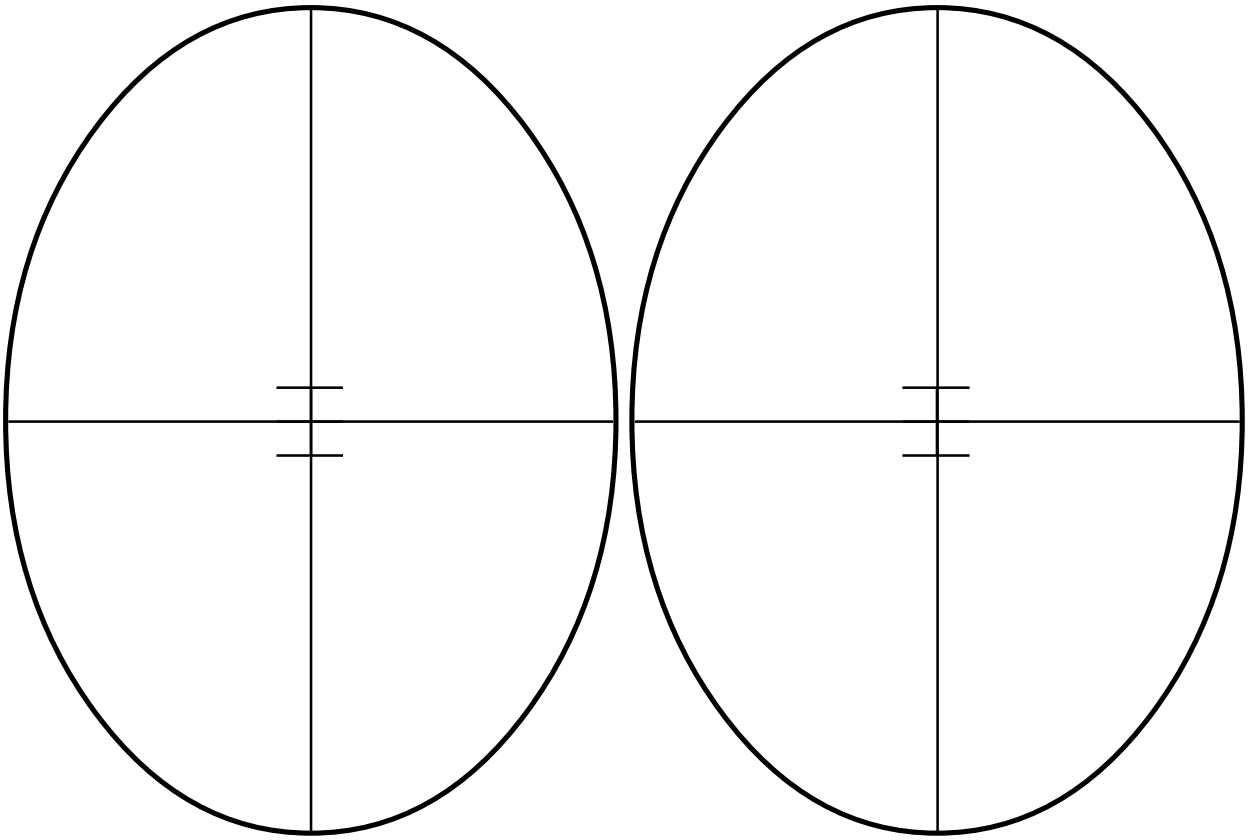
Take a square of clean lint free cotton cloth, pour the cooled crystals into the center and tie it up into a pouch. I used a small cloth drawstring bag that held bubble gum being sold at my local Walgreens. Turn the bag inside out and wash it before you use it. Stuff the pouch into the perforated cannister, replace the top and insert as a plug for your focus tube. Once a month, remove the crystals from the pouch and bake again to "recharge" their effectiveness.

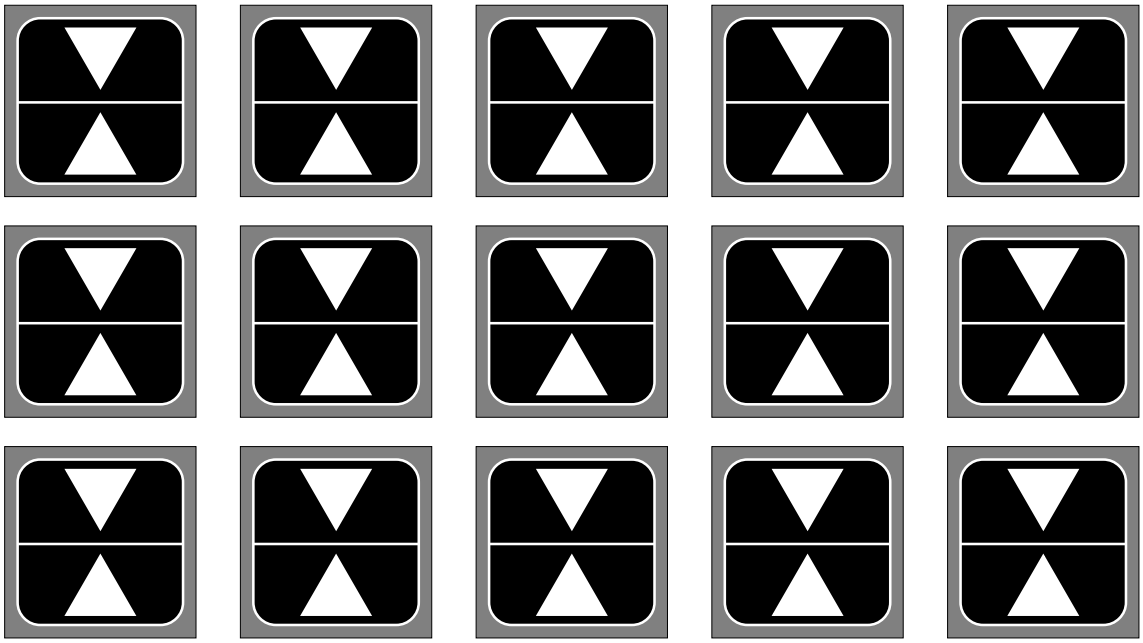
***Clear Skies & Good Viewing To All...***

**Primary Mirror Center Spot Template**
**Objective Target**
**Meade AR5 / AR6 / SN6 / SN8 / SN10**



**Meade SN10 - Secondary Mirror Alignment Template**
**with 1/8” offsets**





**Print on a sheet of Standard UPS Shipping Labels. Available anywhere where they print their own labels. There are two 8.5 x 5.5 labels on a page of heavey self adhesive white paper.**

# Acknowledgements:

***There are several products, dealers and websites referenced in this document which I found to be very useful in the setup of my scopes and mounts. While this is not an endorsement of any particular dealer and or products, it is simply a representation of products and dealers that have provided excellent support and service in my quest to enjoy the hobby.***

## *WebSites*

**http://zebu.uoregon.edu/~mbartels/kolli/kolli.html**
**http://www.heavensandearth.com/Support/EQ3and5.pdf**
**http://www.efn.org/~mbartels/tm/collimat.html**
**http://www.astro-tom.com/telescopes/newtonian.htm**
**http://home.earthlink.net/~flyj/mccluneytext.html**
**www.lefevre.darkhorizons.org/lxd55/clipectomy.htm**
**http://www.lxd55.com/**
**http://www.arksky.org/**
**http://www.weasner.com/lxd/**
**http://www.weasner.com/etx/menu.html**
**http://www.starizona.com/basics/polarg3.html**

## *Dealers / Products*

**http://www.optcorp.com**
**http://www.scienceandhobby.com**
**http://store.proastronomer.com**
**http://home.earthlink.net/~flyj/cecphome.html**
**http://www.telescope.com**
**http://www.amateurastronomy.com/tools.html**
**www.scopestuff.com**

## *User Groups*

**http://groups.yahoo.com/group/LXD55telescopes**
**http://groups.yahoo.com/group/Meade_Autostar**
**http://groups.yahoo.com/group/meade_refractors**
**http://groups.yahoo.com/group/LXD55Portal**

***And many others too numerous to mention.... Thanks to all!***