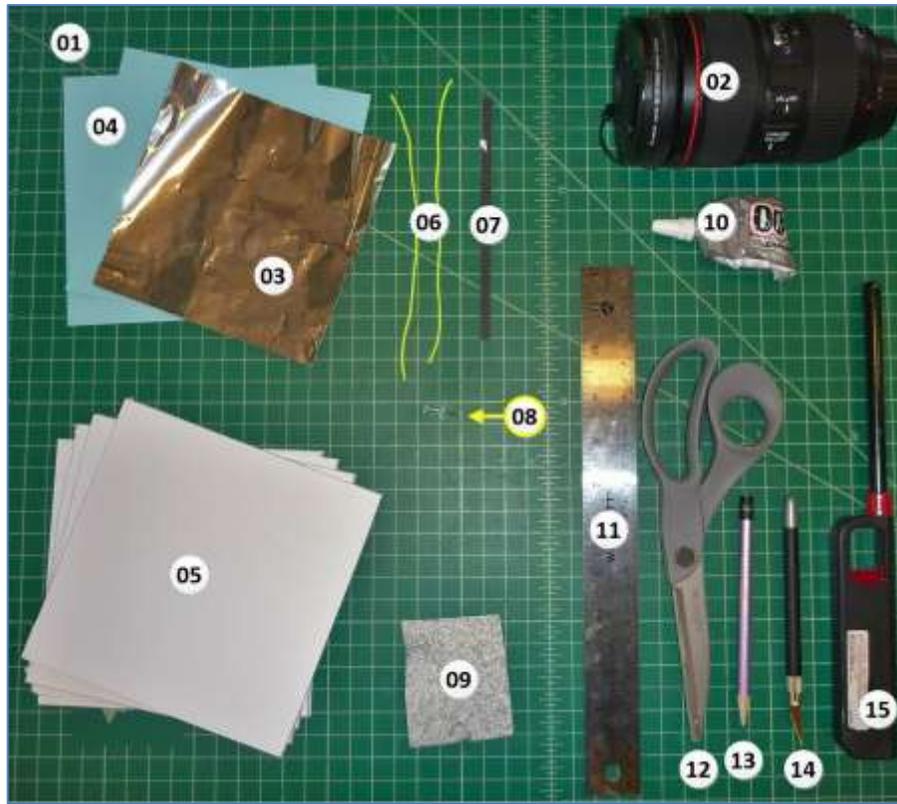


Create your own Solar Filter

Introduction

Instructions provided here detail the step-by-step process involved in creating a solar filter for your telescope by utilizing specialized solar film for viewing the sun. It is critical that film manufactured by a reputable manufacture be utilized; both [Thouand-Oaks Optical](#) and [Baader Planetarium](#) are well known for the quality of their products and either should work nicely for this project. Here is [a comparison](#) I found online between the two products. Both filters are broad spectrum filters eliminating most of the light from the sun making it safe to view the sun through your telescope. Broad spectrum filters are excellent for observing sunspots, eclipses and inner plane transits across the sun. These types of filters cannot be used for viewing solar flares.

Materials Needed



To construct your solar filter you will need the following materials:

1. **Safe Cutting Surface:** A working surface it will be safe to cut on and not worry about damaging the surface.
2. **Optical Tube Assembly (OTA):** The optical tube assembly of the object you will be using to observe the sun. In this example we will be using a camera lens.
3. **Solar Filter Film:** At least 1" larger than the diameter
4. **Sheets of Paper (2):** Two square sheets of paper cut to 1" larger than the diameter of the OTA.
5. **Foam Board (4):** Four square sheets of [foam board](#) cut to 1" larger than the diameter of the OTA. Ideally we will only use 3, but we have one extra in case we make a mistake.
6. **Nylon Twine (2):** Two strips of nylon twine cut to about 5" in length.
7. **Construction Paper Strip:** Measuring approximately ¼" wide and 1" longer than the diameter of the OTA.
8. **Push Pin:** Used for marking reference points and as part of the paper compass that we will make.
9. **Sand Paper (1):** About a 3" square of rough grit sandpaper (60 grit) for smoothing out rough cuts and edges.
10. **Glue:** Some type of good glue that will hold. I use [E600](#) for this demo.
11. **Ruler**
12. **Scissors**
13. **Pencil**
14. **Craft Cutting Knife:** [Exacto type](#) cutting knife.
15. **Heat Source:** Matches, Lighter, etc for melting the end of the Nylon Twine.

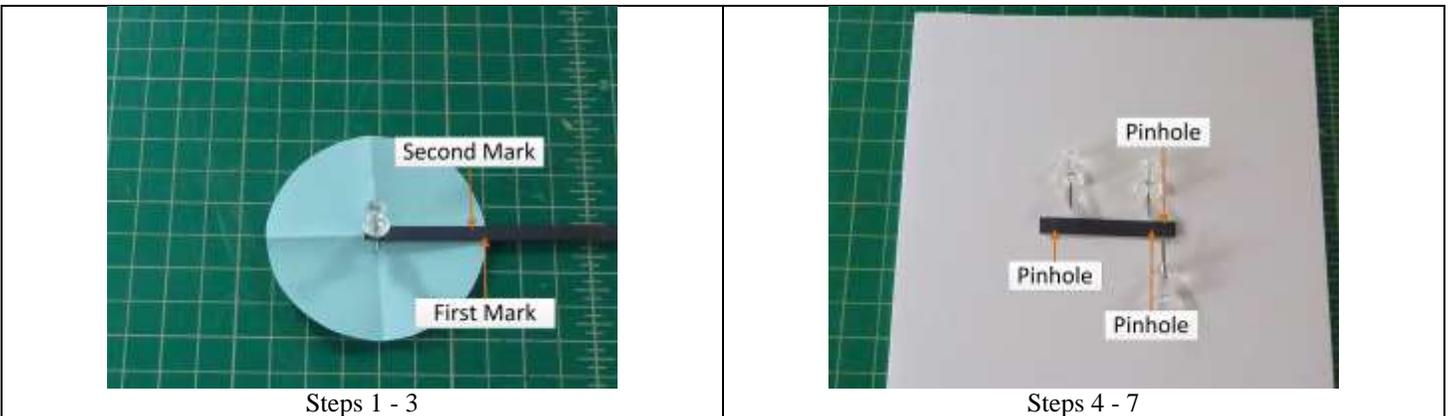
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Creating the Solar Filter



Measuring the radius of the OTA

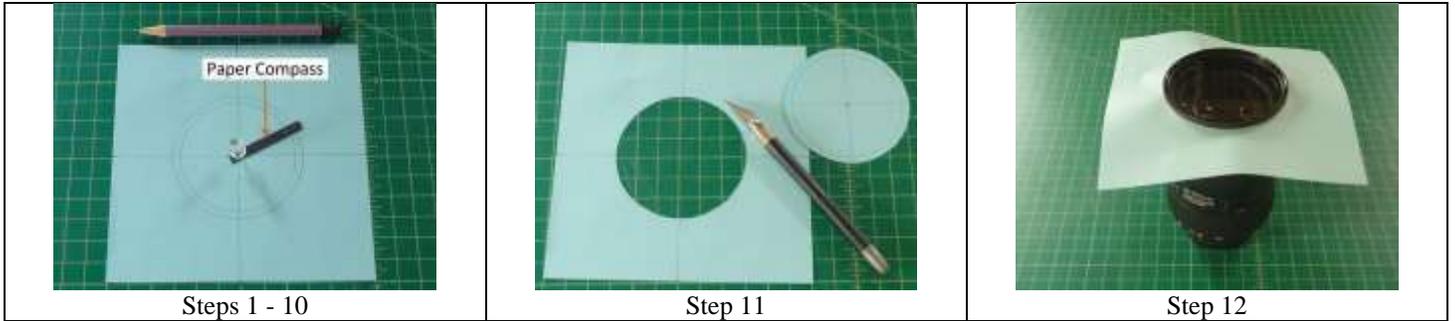
1. Place the **OTA** face down roughly in the center of on a **Sheet of Paper** and using the **Pencil** trace the outline of the OTA on the paper. Remove the **OTA**.
2. Cut out the outline of the OTA from the Sheet of Paper, you should have a circle that represents the size of hole we will need for creating the solar filter in the foam boards. We will refer to this as the **Reference Disk**.
3. Taking the **Reference Disk**, fold it in half, and then in half again so that now you have a quarter section of the circle. Measure the length of one of the flat edges, this measurement is the **OTA Measured Radius** of we will use in the future.
 - a. Record the OTA Measured Radius here: _____
4. Unfold the **Reference Disk**, the intersection of the folds should represent the center point. Use the push pin to place a hole at this intersection (the center of the Reference Disk).



Create a Paper Compass

1. Take the **Construction Paper Strip** and force the **Push Pin** about $\frac{1}{4}$ of an inch from the end of the strip.
2. Place the **Push Pin** and **Construction Paper Strip** in the center of the **Reference Disk** where we had already pushed the push pin.
3. The **Construction Paper Strip** should be longer than the **Reference Disk**. We will now mark two locations on the Construction Paper Strip. The first should be marked at the edge of the Reference Disk and the second should be placed about $\frac{1}{4}$ " in from the edge of the Reference Disk.
4. Remove the Construction Paper Strip from the Reference Disk
5. Cut excess length from the **Construction Paper Strip** about $\frac{1}{4}$ from the outer most tick.
6. Now push holes in both of the tick marks we had just made on the **Construction Paper Strip**.
7. Or compass construction is complete; this will now be referenced as the **Paper Compass** going forward.

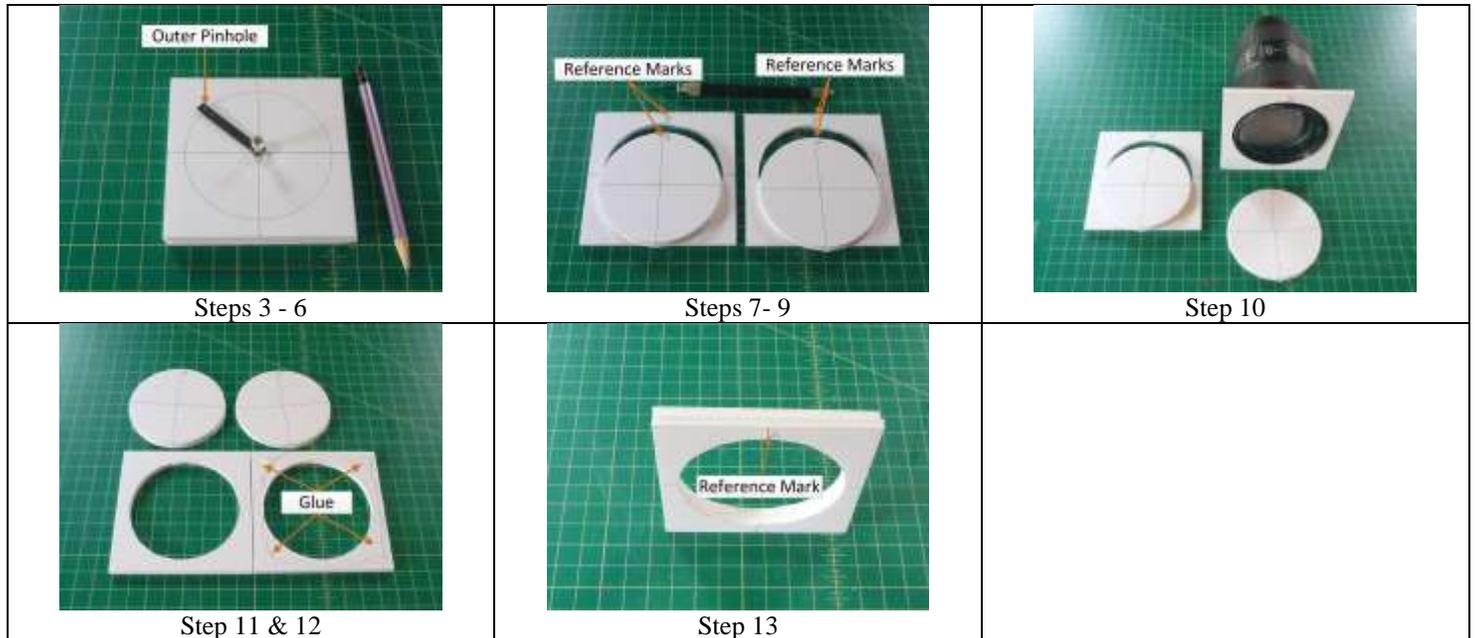
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Test Run – Paper Cut Out

1. We will have a test run on a sheet of paper to make sure we have all measurements and technique correct.
2. Using the second **Sheet of Paper**, measure a square that is 1" larger than the OTA Diameter. This is calculated as $2 \times \text{OTA Measured Radius} + 1"$. For example if our OTA Measured Radius was 4.5", our Square size would be calculated as: $4.5" \times 2 + 1" = 10"$ **Square**
3. Once the square has been measured, cut the square out of the paper. This will be referenced as our **Square Paper**.
4. Place tick marks $\frac{1}{2}$ way down the edge of all four sides of the **Square Paper** and draw two lines that intercept in the middle that divides the Square into 4 sections.
5. Use the **Push Pin** to put a reference hole at the center of the **Square Paper** where the lines intersect. Remove the **Push Pin**.
6. Take the **Paper Compass** and place the **Push Pin** through the hole created earlier on the end of the compass where there is only one hole.
7. Line up the **Paper Compass** with the **Push Pin** up with the center point of the **Square Paper** and push it in in the center point. We are now ready to mark two circles with our compass. Make sure the push pin is firmly placed and the pin does not wiggle or move easily, you may need to place a piece of cardboard or extra foam board underneath for the pin to go into.
8. Once the compass has been secured to the Square Paper, place the tip of your pencil in the inner-most hole on the outer radius of the compass and trace a circle on the paper.
9. Proceed to make trace another circle using the outer-most hole of the compass.
10. At this point you should have two circles, the outer-most circle represents the Outer OTA diameter, and the Inner-Circle represents the stop where the OTA will bump up against when we place the filter on the OTA. We will NOT be utilizing the Inner circle for the test run here.
11. Using the **Craft Cutting Knife**, cut out the Outer most circle from the **Square Paper**.
12. Take the **Square Paper** with and see if it will fit over OTA, Hopefully it just fits over, if not try to figure out what you have done wrong and make appropriate corrections before proceeding.

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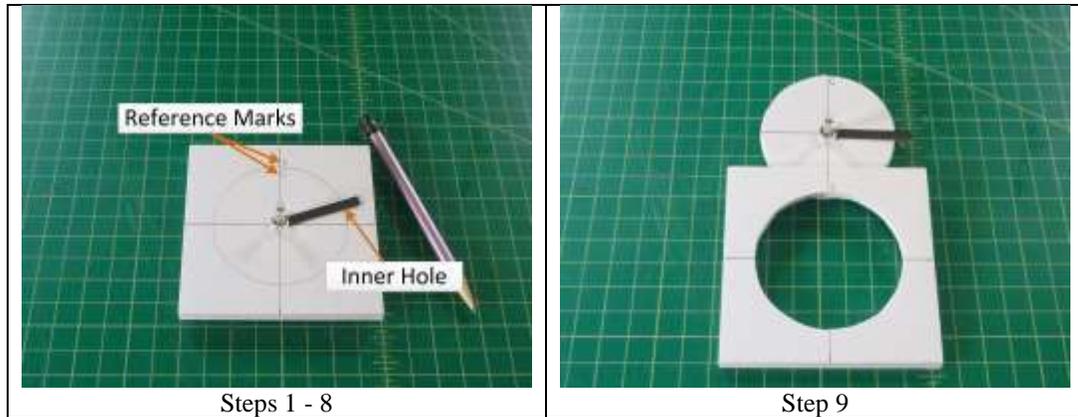


Supporting Structure

We will create two **Foam Boards** that will slide over the OTA and help ensure the filter does not easily fall off the OTA. The method of creating these sheets will be very similar to the test run we just finished.

1. Taking two **Foam Boards**, measure and mark a square that is 1" larger than the OTA Diameter on each board. This is calculated as $2 \times \text{OTA Measured Radius} + 1"$. For example if our OTA Measured Radius was 4.5", our Square size would be calculated as: $4.5" \times 2 + 1" = 10"$ Square
2. Once the square has been measured, cut the square out of each of the **Foam Boards**. This will be referenced as our **Support Boards**.
3. Place tick marks $\frac{1}{2}$ way down the edge of all four sides of each of the **Support Boards** and draw two lines that intercept in the middle that divides the Square into 4 sections.
4. Use the **Push Pin** to put a reference hole at the center of the **Support Boards** where the lines intersect. Remove the **Push Pin**.
5. Take the **Paper Compass** and place the **Push Pin** through the hole created earlier on the end of the compass where there is only one hole.
6. Line up the **Paper Compass** with the **Push Pin** up with the center point of the **Support Board** and push it in in the center point. We are now ready to mark the OUTER circle with our compass. Make sure the push pin is firmly placed and the pin does not wiggle or move easily, you may need to place a piece of cardboard or extra foam board underneath for the pin to go into.
7. Once the compass has been secured to the **Support Board**, place the tip of your pencil in the OUTER-MOST hole on the outer radius of the compass and trace a circle on the paper.
8. Add Reference Points – We want to keep one of the cut-out circles from the **Support Board** to use as a cover for the solar filter. Since we can't hope to cut a perfect circle it is a good idea to place a reference mark both on the cut-out and the Support Board, so we can make sure to orient the cut-out when we use it as a cover later (we will only need one).
9. Using the **Craft Cutting Knife**, cut out the circle from the **Support Board**.
10. Take the **Support Board** with and see if it will fit over OTA, Hopefully it just fits over, or almost fits, we can make small adjustments later to enlarge it with the sandpaper.
11. Complete this process on both **Foam Boards**.
12. Lay down both boards so the reference points are facing down and tab glue on the face of one of the boards.
13. Take both **Support Boards** and press them face-to-face with the lines and reference marks facing out so they are visible creating the **Supporting Structure**.
14. Place the **Supporting Structure** aside to dry

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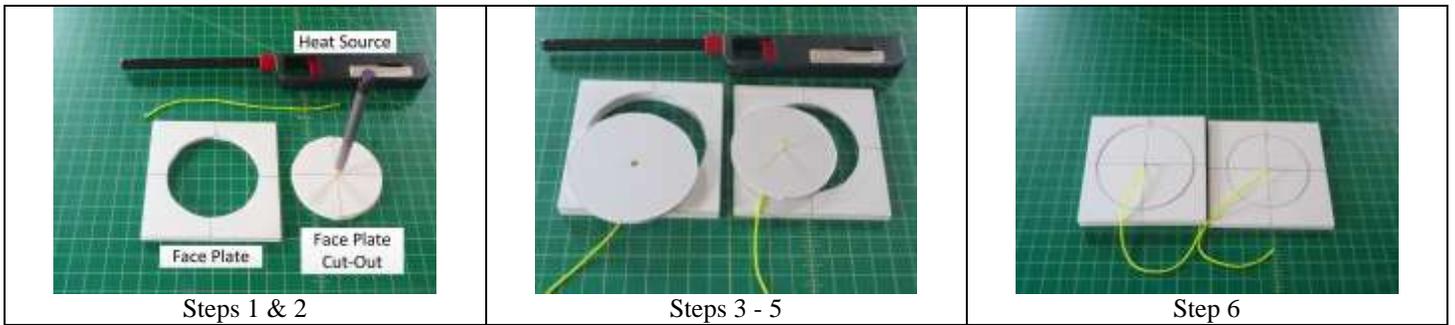


Face Plate

Using the third **Foam Board** we will create the face plate that will bump up against the OTA when placing the filter on the OTA. The method of creating these sheets will be very similar to the Support Structure process we just completed with the exception of there only being one piece, and the circle we will mark and cut out is SMALLER than the one we did in the Support Structure.

1. Take the third **Foam Board**, measure and mark a square that is 1" larger than the OTA Diameter on each board. This is calculated as $2 \times \text{OTA Measured Radius} + 1''$. For example if our OTA Measured Radius was 4.5", our Square size would be calculated as: $4.5'' \times 2 + 1'' = 10''$ Square
2. Once the square has been measured, cut the square out of the **Foam Board**. This will be referenced as our **Face Plate**.
3. Place tick marks $\frac{1}{2}$ way down the edge of all four sides of the **Face Plate** and draw two lines that intercept in the middle that divides the Square into 4 sections.
4. Use the **Push Pin** to put a reference hole at the center of the **Face Plate** where the lines intersect. Remove the **Push Pin**.
5. Take the **Paper Compass** and place the **Push Pin** through the hole created earlier on the end of the compass where there is only one hole.
6. Line up the **Paper Compass** with the **Push Pin** up with the center point of the **Face Plate** and push it in in the center point. We are now ready to mark the INNER circle with our compass. Make sure the push pin is firmly placed and the pin does not wiggle or move easily, you may need to place a piece of cardboard or extra foam board underneath for the pin to go into.
7. Once the compass has been secured to the **Face Plate**, place the tip of your pencil in the INNER-MOST hole on the outer radius of the compass and trace a circle on the paper.
8. Add Reference Points – We want to keep one of the cut-out circles from the **Face Plate** to use as a cover for the solar filter. Since we can't hope to cut a perfect circle it is a good idea to place a reference mark both on the cut-out and the Face Plate, so we can make sure to orient the cut-out when we use it as a cover later.
9. Using the **Craft Cutting Knife**, cut out the circle from the Foam Board.

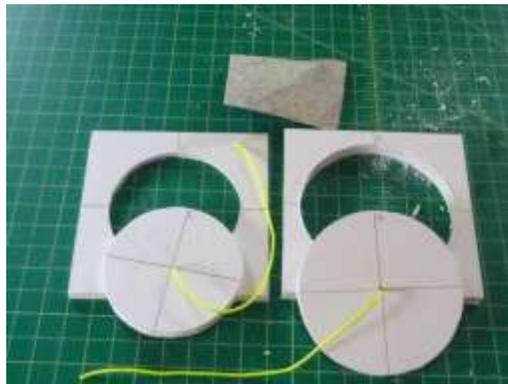
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Filter Covers

Using the cut-out circle from one of the **Support Boards**, and the cut out circle of the **Face Plate** we will attach the **Nylon Twine** so we can easily remove the covers. The process is identical for both covers.

1. Take the Cut Out circle and use the Punch Pin to make sure the center point hole goes completely through the foam board. Use a pencil to make the hole a little bigger, we want to be able to just force the twine through the hole.
2. Taking the Cut Out Circle, and starting from the side with the reference marks force the twine through the center hole using your pencil.
3. Force enough Twine through the hole so that about 1/8 – 1/16 of an inch of the twine comes out of the Foam Board.
4. Using a match, or other heat source, melt the end of the twine and quickly place this face down on a flat surface so the melted twine flattens out.
5. Melt the tip of the other end of the string so that it doesn't fray with time.
6. Repeat this process to create the cover for the other side of the filter.



Sanding Down

Here we make final adjustments to the Supporting Structure and clean up the edges of everything.

- Once the glue in the Supporting Structure has had time to dry, check to see if it will slide onto the OTA. If not, use your sand paper to slightly increase the opening of the Supporting Structure until it will fit on the OTA.
- Use your sand paper to take any sharp edges off any of the cut surfaces on any of the pieces created so far.
- Clean up your work area and remove any debris left from the work you have done so far.

Prepare Solar Filter Film

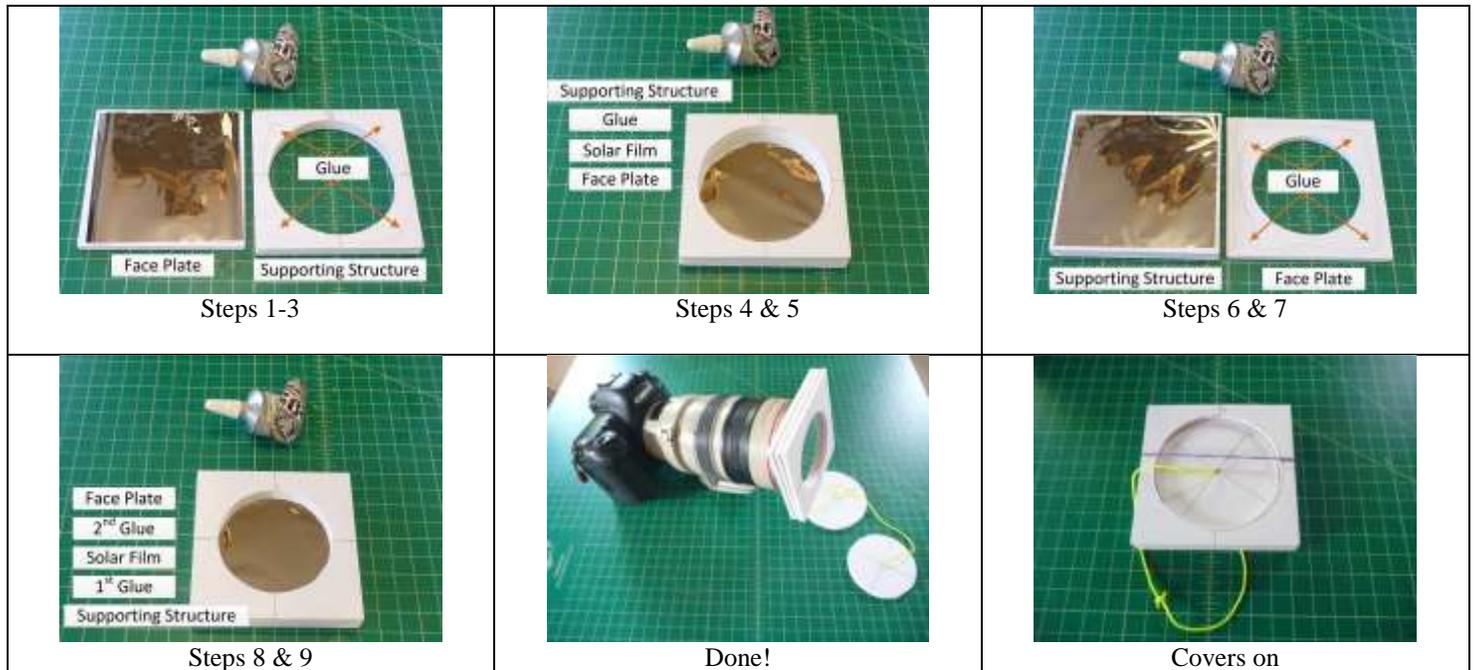
We now measure and cut the Solar Film that will be used for the filter

- Using the **Solar Filter Film**, measure a square that is $\frac{3}{4}$ " larger than the OTA Diameter. This is calculated as $2 \times \text{OTA Measured Radius} + \frac{3}{4}$ ". For example if our OTA Measured Radius was 4.5", our Square size would be calculated as:

$$4.5'' \times 2 + \frac{3}{4}'' = 9 \frac{3}{4}'' \text{ Square}$$

- Once the square has been measured, cut the square out of the **Solar Filter Film**.

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Final Assembly

We are now ready to perform the final assembly of our filter.

1. Place the **Face Plate** with the **Reference Mark** face down on the left and the **Supporting Structure** with on the right of the **Face Plate**.
2. Take the **Solar Film** and place it on the Face Plate and make sure it is centered, make sure there are no wrinkles on the film. If this is a large filter and the **Solar Film** is sagging in the hole of the **Face Plate**, you may need to put the circle you cut out of the **Face Plate** back in the plate to support the **Solar Film**.
3. Place a thin bead of **Glue** on the exposed surface of the **Face Plate**.
4. Pick, up the Supporting Structure and place it on the Face Plate so the Glue is sandwiched between the Solar Film and the Supporting Structure. Make sure all edges are lined up.
5. Gently press to make sure the glue spreads out. The stacking order should now be (From bottom layer to top):
| Face Plate | Solar Film | Glue | Supporting Structure |
6. Flip over everything so that now the Supporting Structure is on the bottom and lift off the Face Plate and place it next to the supporting structure.
7. Apply a bead of glue around the edge of the surface of the Face Plate that was up against the Solar Film before removing the Face Plate.
8. Pick, up the Face Plate and place it on the Supporting Structure so the Glue is sandwiched between the Solar Film and the Face Plate. Make sure all edges are lined up.
9. Gently press to make sure the glue spreads out. The stacking order should now be (From bottom layer to top):
| Supporting Structure | 1st Glue | Solar Film | 2nd Glue | Face Plate |
10. Let glue dry
11. Filter should now be ready to use