Fresnel Lens Design

Tutorial Overview

We will develop a standard Fresnel lens to collimate the light from a COB source into as narrow of a beam as possible. Fresnel lenses are useful in that you can achieve a narrow beam while keeping your lens thickness more uniform and easier to mold. Tradeoffs in these style designs can be seen with lower efficiency since the lens only controls a portion of the original distribution from the source, and less beam control since there is a fillet on each peak and valley connecting the prisms.

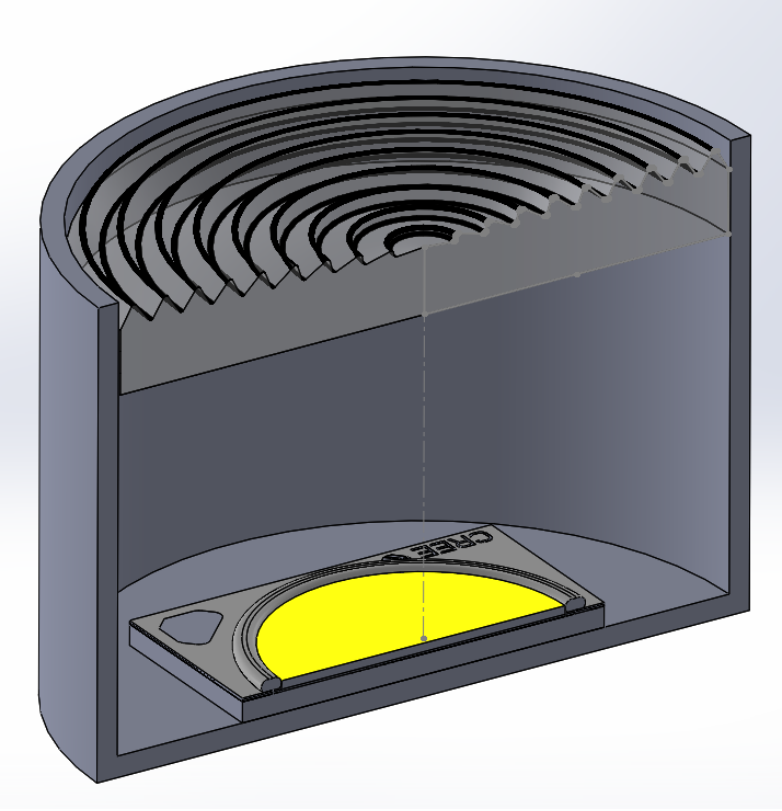
Topics Covered

- Fresnel Lens
- Refractor Design Tools
- PODT in SolidWorks

Skill Level - Intermediate

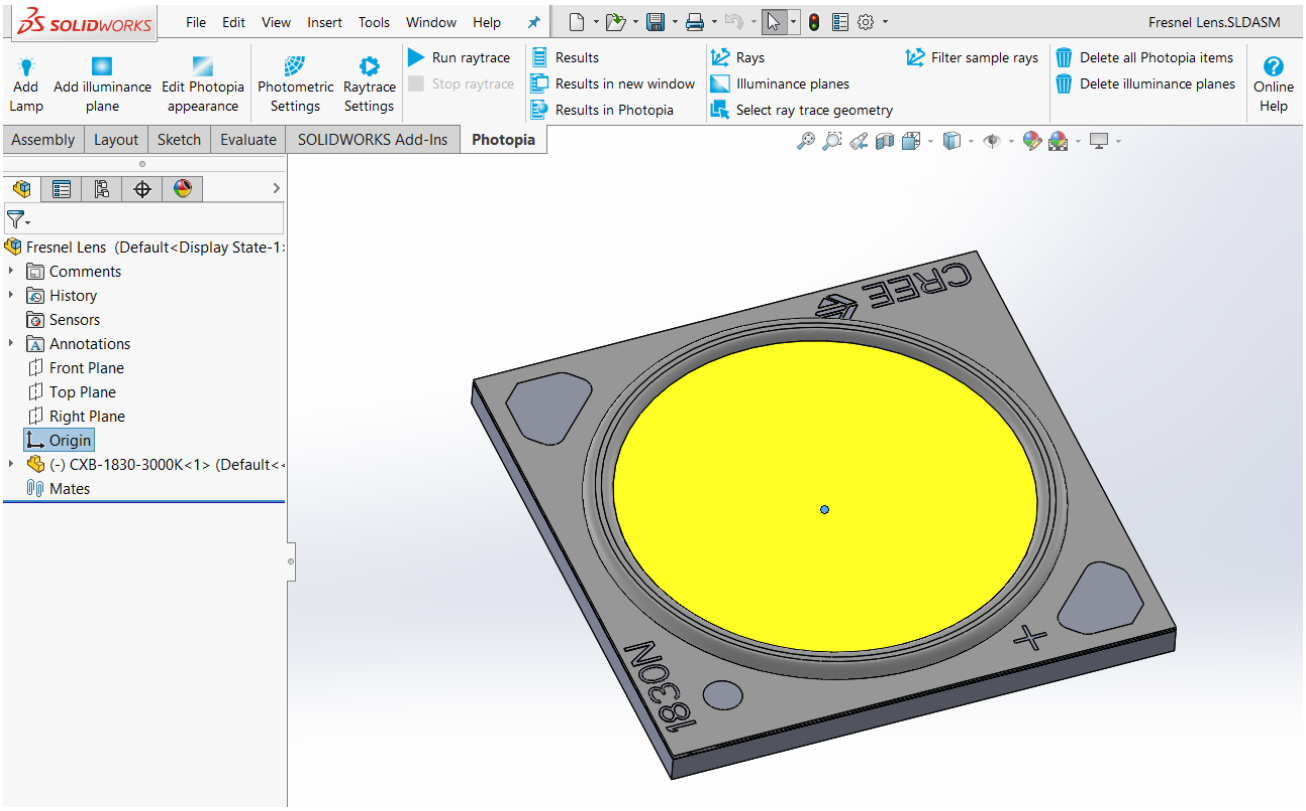
Interface - Photopia for SOLIDWORKS

Estimated Completion Time - 30min



Initial Assembly Setup

1. Open SOLIDWORKS and start a new Assembly document.
2. Make your assembly units in Metric (MMGS).
3. Save the assembly as “Fresnel Lens”.
4. From the Photopia CommandManager, click “Add Lamp”.
5. Click on “Browse Lamps”. In the “Choose a Lamp” menu type “CXB” into the search bar, this will show all the lamps with “CXB” in the name. Double click on the “Cree CXB-1830-3000K” lamp designation. Click OK (✓) to insert the lamp at the assembly origin.

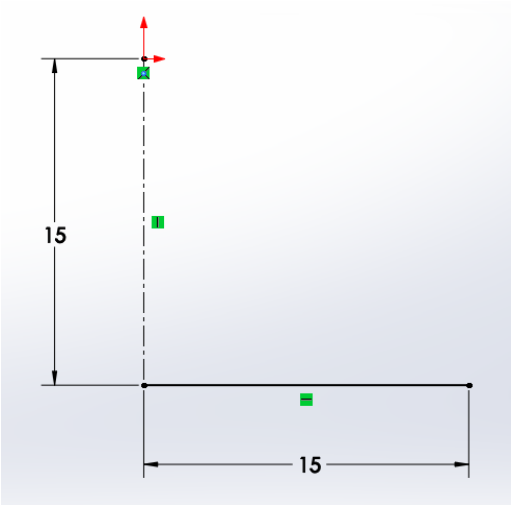


6. Save the assembly.

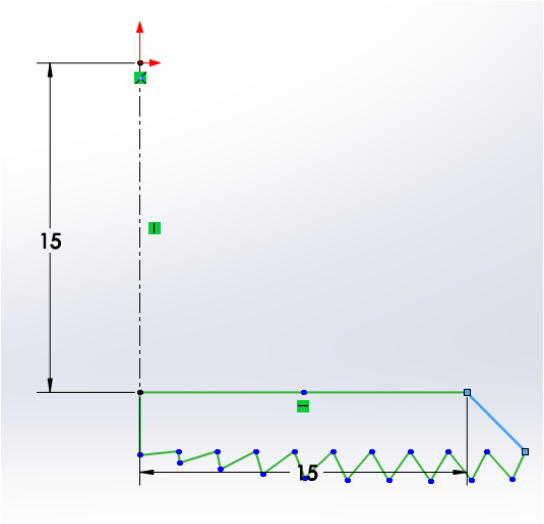
Design the Fresnel Lens

7. Go to File > New, and select a new part document.
8. Make your part units in Metric (MMGS).
9. Save the part as “Fresnel Lens”.
10. Begin a new sketch on the Top Plane.
11. Draw a centerline from the origin straight down. Make the centerline 15mm long. The centerline will define our lamp center, and our 0° aiming direction.

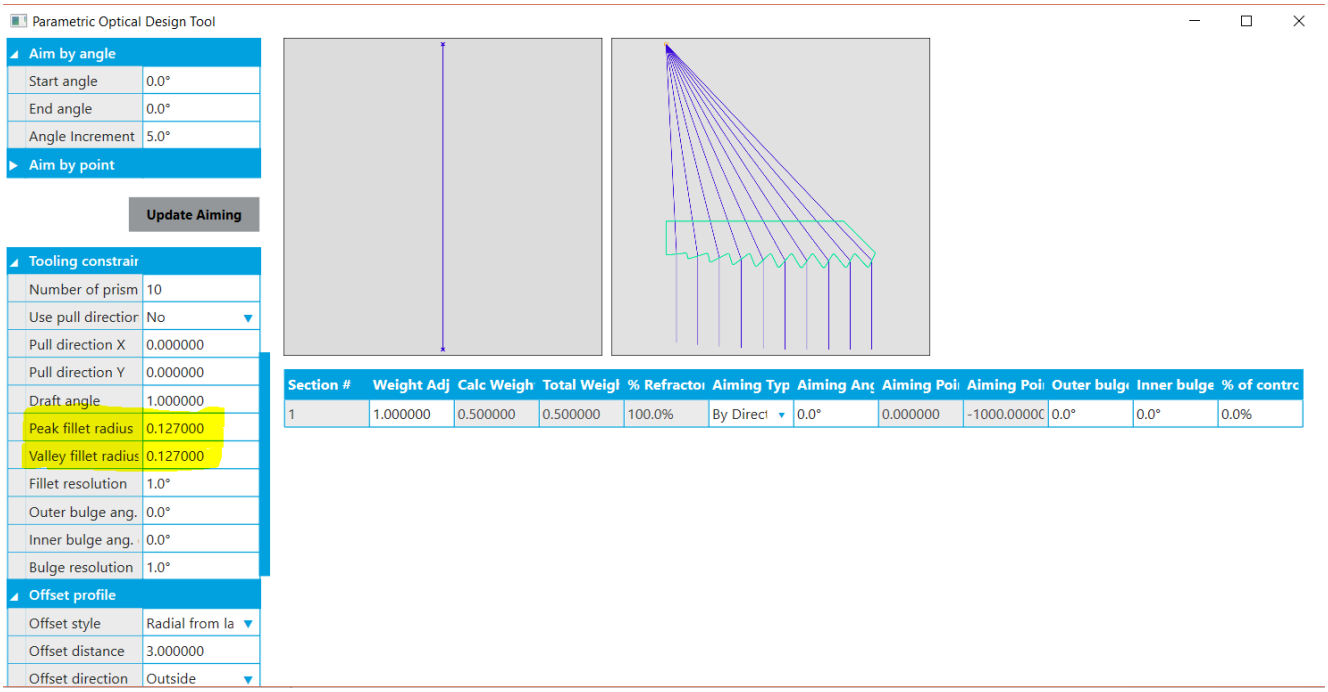
12. Draw a line from the origin straight to the right. Make the line 15mm long (so the lens will be 30mm in diameter). This line will serve as our base profile to create the revolved Fresnel disk.



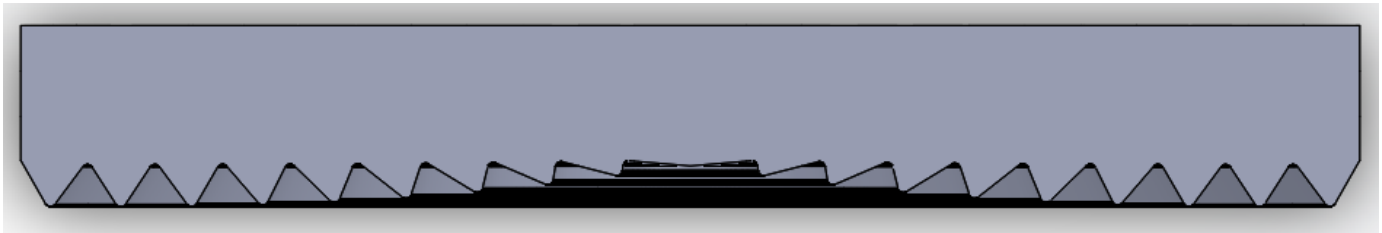
13. Click on the Photopia CommandManager and select “Design Lens”.
14. Use the following parameters:
    a. The Lamp Center is the origin at the top of the centerline.
    b. The base profile is the horizontal line.
    c. We will keep the default number of Prism Steps at 10
    d. We will keep the default Index of Refraction at 1.491 for generic acrylic.
    e. Additionally we will keep the default Minimum Thickness at 3.00mm.
    f. The edge to define the 0° aiming angle is the centerline.
    g. Last, our goal is to create as narrow a beam as possible, so we will adjust the aiming string to be “0(5)0” which means that the lens is aimed at 0° at the start of the profile, 0° at the end of the profile, and changes in 5° increments (which does not matter here since we have the same aiming angle at the start and the end). Click OK (✓) to complete the lens design.



15. Click on the Features CommandManager and select “Revolved Boss/Base”. The Axis of Revolution is the centerline and we will use Blind and 360° Direction1 settings. Click OK (✓) to complete the revolved feature and close the sketch.
16. In the FeatureManager Design Tree select the “Revolve1” feature. Click on the Photopia CommandManager and select “Design Lens”. Under “Reload” select the PODT Refractor that you designed, and Click OK (✓) to connect that design profile to the revolve feature, allowing you to adjust the profile in the future without recreating the feature.
17. We will add fillets to the peaks and valleys of the lens. Select the “Revolve1” feature, go to Photopia > Design Lens, and click “Open the PODT Window”. Under Tooling Constraints change the Peak fillet radius and Valley fillet radius to be 0.127mm (a standard injection molding fillet radius). Exit out of the PODT window and click OK (✓) to update your lens profile.



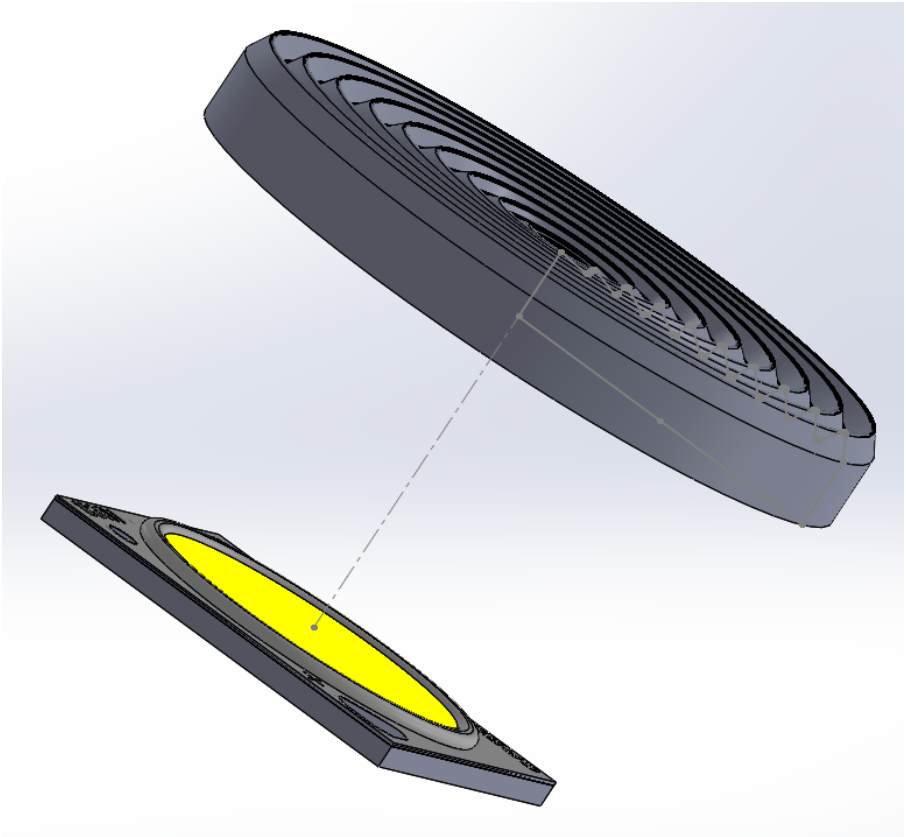
18. Repeat step 17 but change the offset style to be “Simple Offset” this will offset the Fresnel prisms straight to the outside rather than radially from the lamp center. Below is the cross section of your completed Fresnel lens:



19. Save the part.

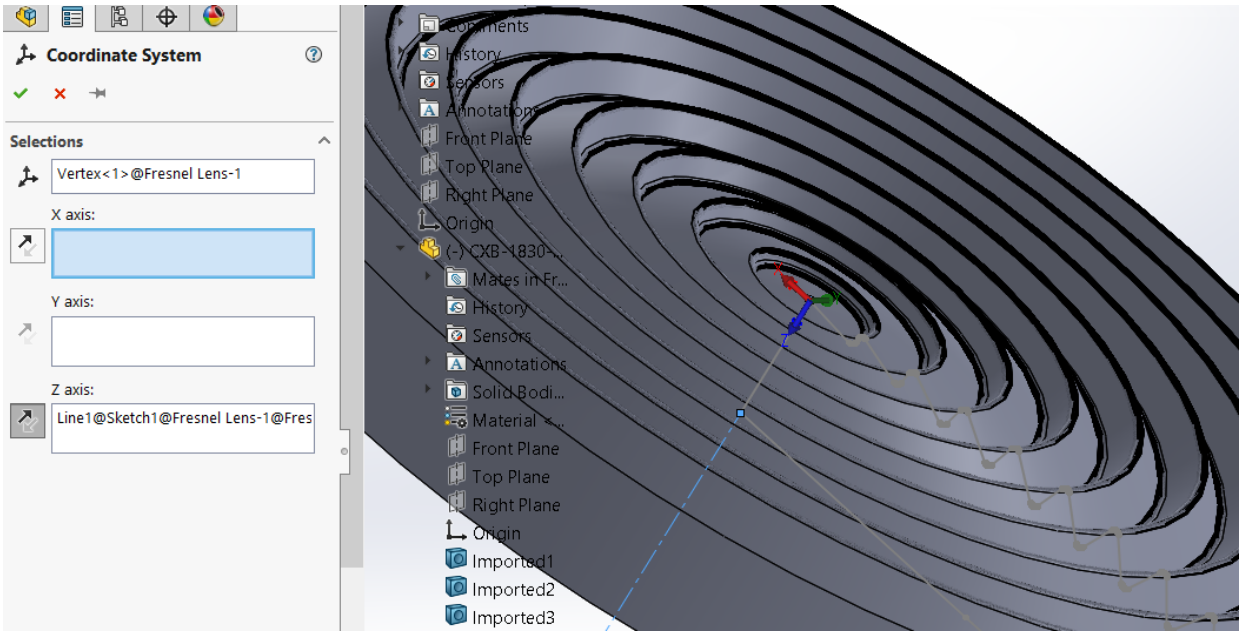
Assembly Completion and Simulation

20. Go back to your Fresnel Lens assembly.
21. Click on the Assembly CommandManager, select “Insert Component”, select the Fresnel Lens part and click OK (✓) to add it to your assembly.
22. As you will see the lens will be added to the model but behind the lamp and facing the opposite direction. We must flip the lens around.
    a. Right click on the lens and change the property from “fix” to “float”.
    b. Select the lens and under the Assembly CommandManager, select Rotate Component (an option under Move Component). Chose by delta XYZ for the rotate option and 180° in the Y axis. Click OK (✓) to commit the rotate.
23. Mate the lamp origin to the lamp center of the lens sketch.
    a. Under the FeatureManager Design Tree, expand the Fresnel Lens part, right click on the sketch and select the option to show the sketch.
    b. Click on mate. Your first point will be the lamp center point from the part sketch. The second point will be the origin from the CXB-1830 lamp part. This will move the lens slightly forward relative to the lamp.

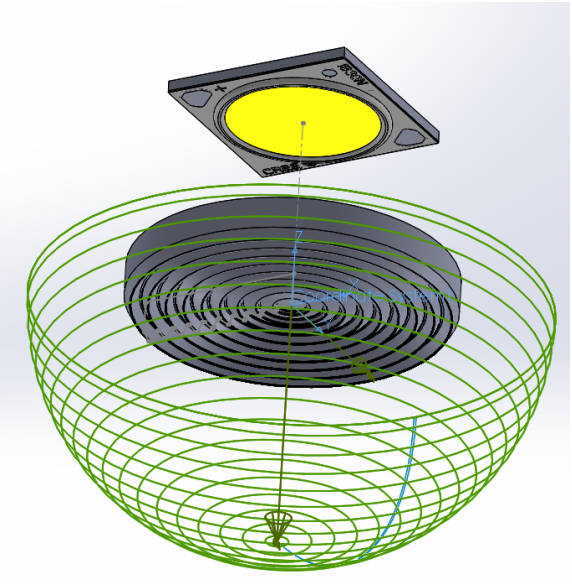


24. Photometric Center and Settings
    a. Add a reference coordinate system by going to Insert > Reference Geometry > Coordinate System. For the origin select the point on the outside center of the lens. The Z axis will be along the sketch centerline

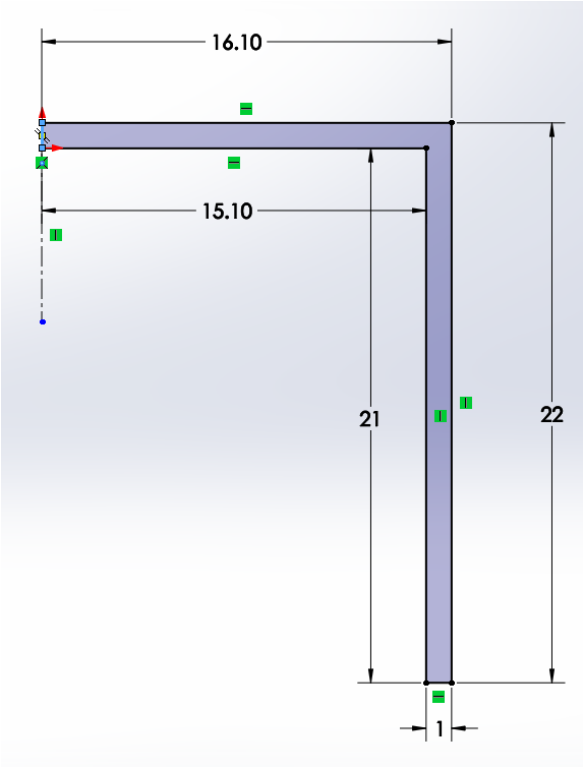
with +Z pointing towards the lamp (0° is towards -Z in IESNA photometric standards). Click OK (✓) to add the coordinate system



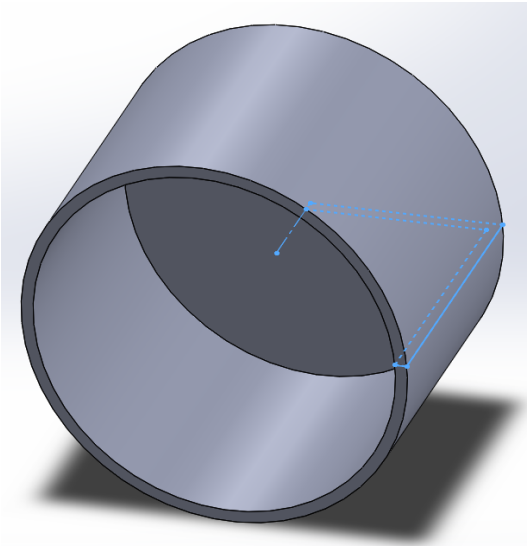
b. Select the new coordinate system and under the Photopia CommandManager select Photometric Settings. Since the product is symmetric our horizontal angle set will just be “0”, and since it is a direct product our horizontal angle set will go from 0° to 90° in steps of 5°. Click OK (✓) to save the Photometric Settings.



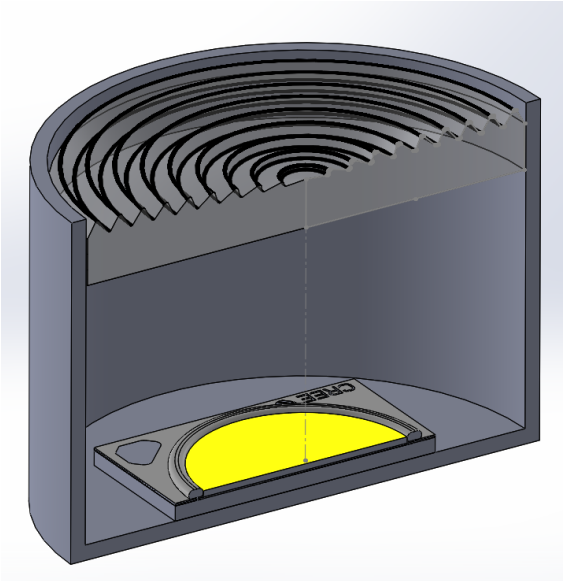
25. Simple Housing
    a. In order to capture the light that is not incident with the lens start a new part to create a simple housing.
    b. Create a sketch for a simple cylindrical shell that will encapsulate the COB and lens:



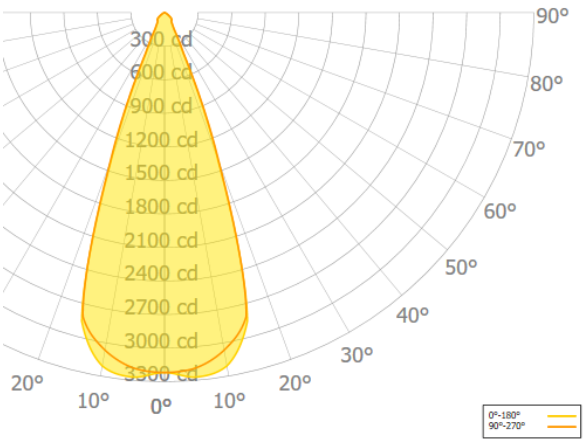
c. Revolve the sketch to create a solid part and save as “Housing”.



d. In the Fresnel Lens assembly insert the Housing part and mate it so the inside horizontal face of the housing is mated with the back face of the COB and it is centered with the COB/lens.



26. Assign materials:
    a. Assign the refractive Generic Clear Acrylic material to the lens part.
    b. Assign the reflective Generic Flat Black material to the housing part
27. Confirm the raytrace settings.
    a. Click on the Photopia CommandManager, select Raytrace Settings.
    b. Keep the default of 2.5mil rays and 25 ray reactions.
    c. Change the Sample Ray Count from 0 to 250 in order to see a sample of the 3D rays.
    d. Click OK (✓) to save the raytrace settings.
28. Save the assembly.
29. Run the raytrace
30. View the results
    a. A beam angle (full width half max) of 38.3° has been achieved, narrowing the beam significantly from the 120° lambertian beam emitted from the COB.



    b. The optical efficiency is 39.6% (the majority of the light loss is absorbed by the black housing).

Complete

Congratulations! You have completed the Fresnel Lens Design tutorial.

For more information and tutorials please visit our website at www.ltioptics.com. If you have any questions don't hesitate to reach out to our support team at photopia@ltioptics.com.