OVERVIEW

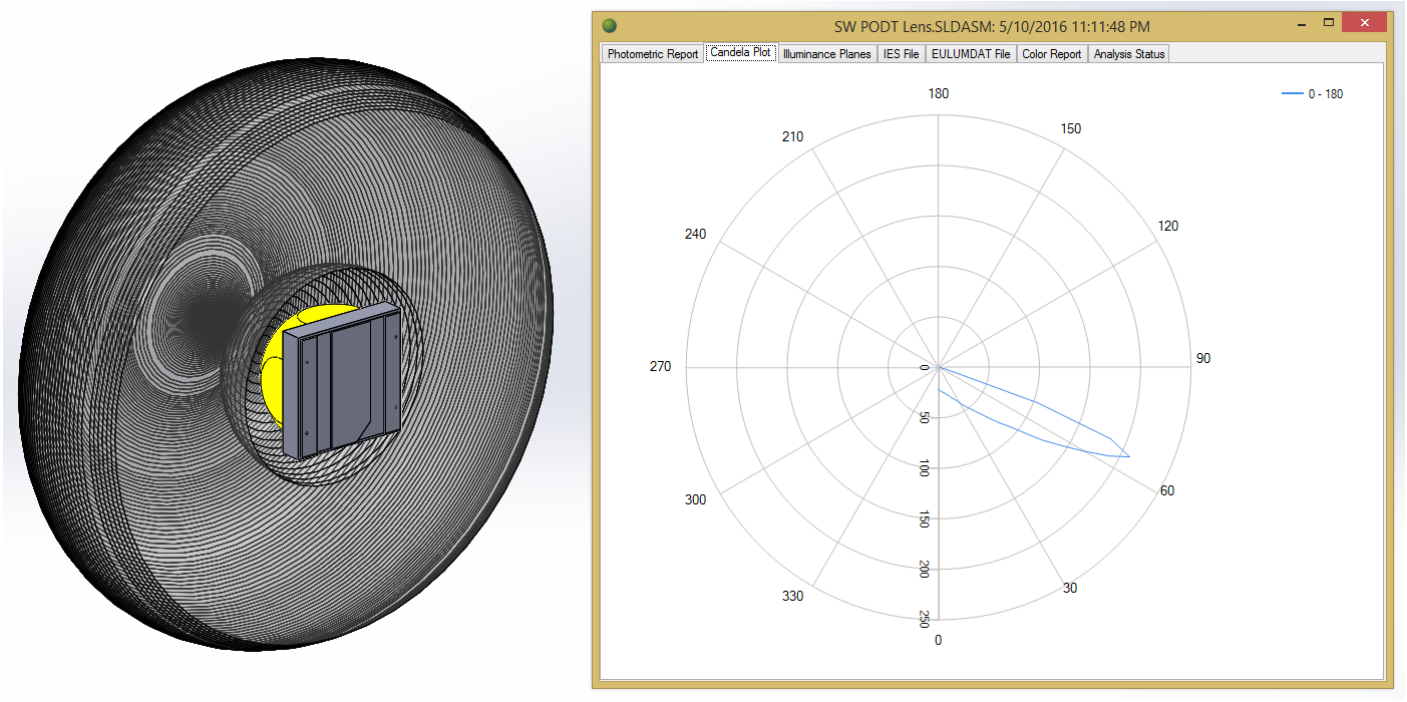
In this tutorial you will design a wide beam lens with a peak beam angle around 65^{o} using the Parametric Optical Design Tools (PODT) and the CREE XP-L LED. The peak intensity value should be at least 8 times the intensity at nadir to ensure even illumination from the center outward, thus avoiding a hot spot under the lens. This tutorial assumes you know how run a Photopia analysis inside of SOLIDWORKS. If you need to review the basics of Photopia for SOLIDWORKS, then start with the Beginner 1: LED TIR Collimator tutorial. http://www.ltioptics.com/en/support-swaddin-v2015.0.html#pswaitutorials

You will need to have access to the General Refractor Module to complete this tutorial.

Skills Covered:

- Design a lens
- Analyze the lens
- Modify the lens to obtain the desired beam shape

Skill Level: Intermediate



1. Start a New Part

Start SOLIDWORKS and click **File > New** and choose a Part. Set the units for the part to be MMGS.

> Photopia's PODT module creates reflector and lens profiles in a sketch in a part file. The profiles are based on several geometric constraints and aiming parameters that you will define beforehand. 3D features based on these profiles are then created using the Feature tools within SOLIDWORKS. When you change the underlying PODT profile, the Features will be updated as well.

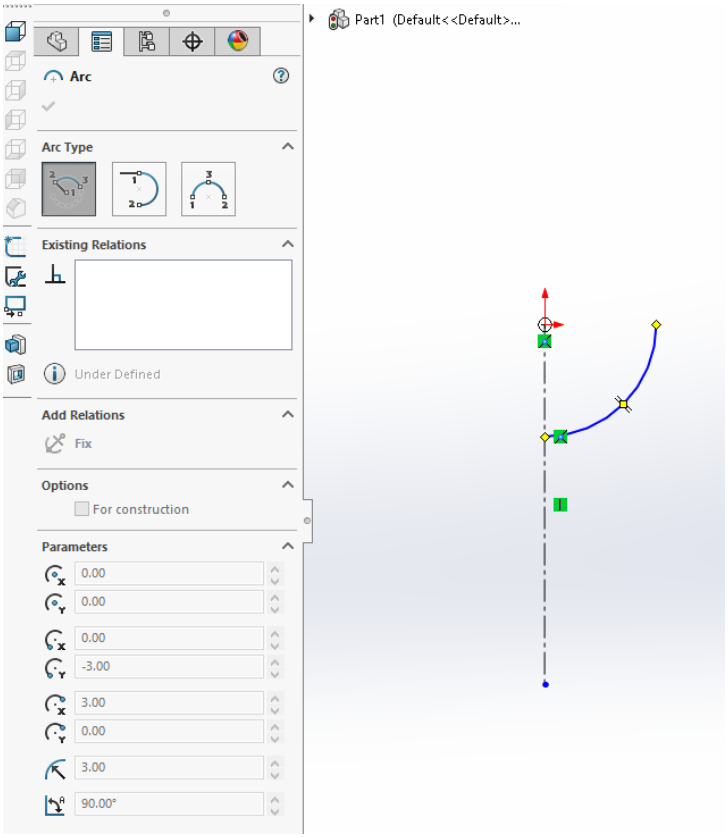
2. Start a Sketch and Define Constraints

Select the **Top Plane** in the Feature Manager Tree, and then choose the **Sketch** tab from the Command Manager and click the **Sketch** button to create a new Sketch.

Next you will create a line which defines the lamp center and beam direction. From the **Sketch** tab in the Command Manager, click on the **Line** button and check "For construction". Click to start the line at the origin and drag it down vertically to be about 10mm long. The exact length isn't critical as this line defines the center of the beam and lens revolve axis.

Next you will create an arch which defines base profile of the lens. In this example, the base profile will be the input surface of the lens.

From the **Sketch** tab in the Command Manager choose the **Centerpoint Arc** tool, click the origin as the arc center, choose a start point along the construction line below the origin, and drag to the right to approximately 90°. To get the precise dimensions, then enter 3 as the radius and 90 as the extent in the PropertyManager as shown to the right.



3. Create the Lens

Ensure the sketch still open and click **Design lens** (Photopia CommandManager Tab) or **Tools > Photopia > Design lens**.

For the **Lamp center** property, select the sketch origin.

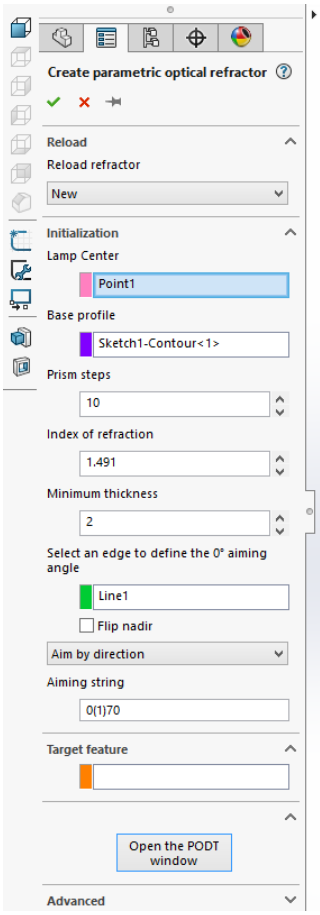
For the **Base profile**, select the arc.

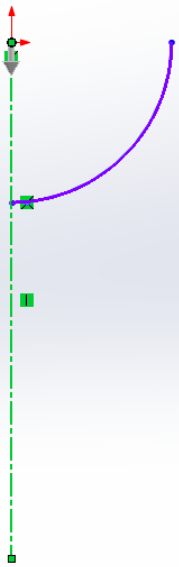
For the **0° aiming direction** select the construction line.

Keep the **Prism steps** & **Index of refraction** at their defaults (we'll assume an acrylic lens).

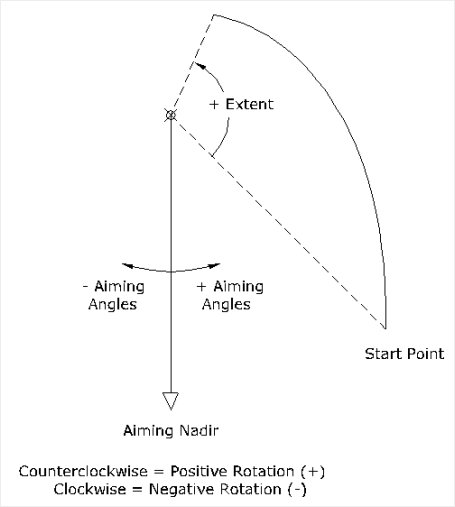
Set the **Minimum thickness** to 2.

For the **Aiming string** enter 0(1)70





The image below shows references for the Aiming Nadir and Aiming Angle Directions for a reflector. The same aiming angle conventions apply to a lens.



The **Aiming string** defines how you want to aim the light from the lens. The goal of this design is to create a wide beam angle with a peak intensity at 65°. In order to achieve the peak intensity at 65°, you'll need to aim light beyond that angle since the beam will continue to taper past the peak. So start with aiming the light 70° from the beam center and the aiming can be adjusted once we see how the lens performs. The Aiming string is entered in the following format:

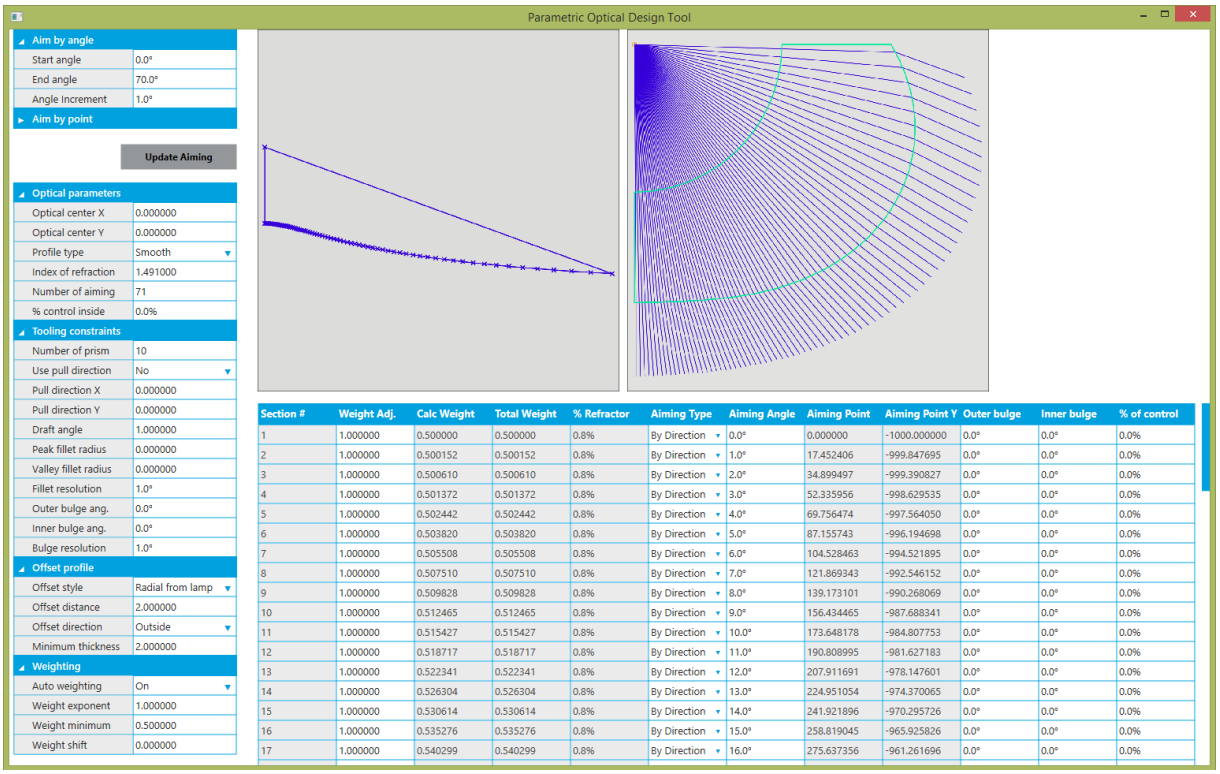
Start angle (Angular Increment) Ending angle

Assuming the bottom of the lens aims light directly down, the top towards the widest angle, and increments between those two extremes of 1°, enter the string:

0(1)70

Click the **Open the PODT window** button.

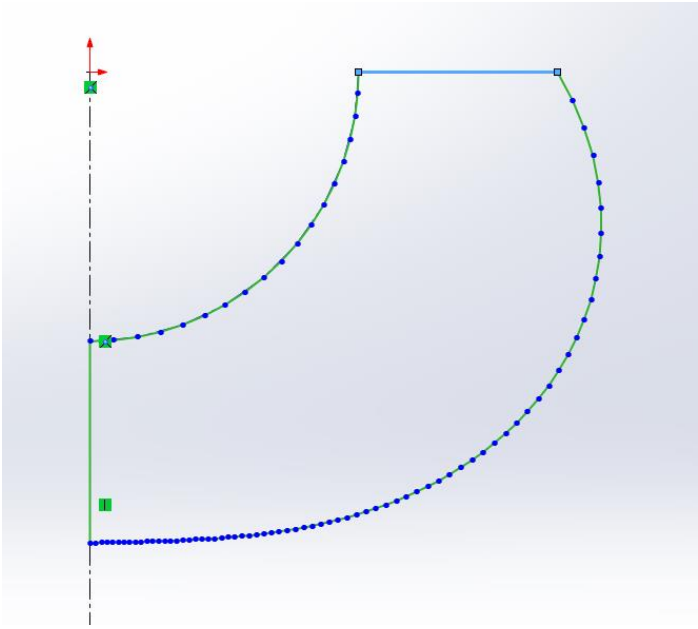
Change the **Profile type** property to **Smooth**.



Section #	Weight Adj.	Calc Weight	Total Weight	% Refractor	Aiming Type	Aiming Angle	Aiming Point	Aiming Point Y	Outer bulge	Inner bulge	% of control
1	1.000000	0.500000	0.500000	0.8%	By Direction	0.0°	0.000000	-1000.000000	0.0°	0.0°	0.0%
2	1.000000	0.500152	0.500152	0.8%	By Direction	1.0°	17.452406	-999.847695	0.0°	0.0°	0.0%
3	1.000000	0.500610	0.500610	0.8%	By Direction	2.0°	34.899497	-999.390827	0.0°	0.0°	0.0%
4	1.000000	0.501372	0.501372	0.8%	By Direction	3.0°	52.335956	-998.629535	0.0°	0.0°	0.0%
5	1.000000	0.502442	0.502442	0.8%	By Direction	4.0°	69.756474	-997.564050	0.0°	0.0°	0.0%
6	1.000000	0.503820	0.503820	0.8%	By Direction	5.0°	87.155743	-996.194698	0.0°	0.0°	0.0%
7	1.000000	0.505508	0.505508	0.8%	By Direction	6.0°	104.528463	-994.521895	0.0°	0.0°	0.0%
8	1.000000	0.507510	0.507510	0.8%	By Direction	7.0°	121.869343	-992.546152	0.0°	0.0°	0.0%
9	1.000000	0.509828	0.509828	0.8%	By Direction	8.0°	139.173101	-990.268069	0.0°	0.0°	0.0%
10	1.000000	0.512465	0.512465	0.8%	By Direction	9.0°	156.434465	-987.688341	0.0°	0.0°	0.0%
11	1.000000	0.515427	0.515427	0.8%	By Direction	10.0°	173.648178	-984.807753	0.0°	0.0°	0.0%
12	1.000000	0.518717	0.518717	0.8%	By Direction	11.0°	190.808995	-981.627183	0.0°	0.0°	0.0%
13	1.000000	0.522341	0.522341	0.8%	By Direction	12.0°	207.911691	-978.147601	0.0°	0.0°	0.0%
14	1.000000	0.526304	0.526304	0.8%	By Direction	13.0°	224.951054	-974.370065	0.0°	0.0°	0.0%
15	1.000000	0.530614	0.530614	0.8%	By Direction	14.0°	241.921896	-970.295726	0.0°	0.0°	0.0%
16	1.000000	0.535276	0.535276	0.8%	By Direction	15.0°	258.819045	-965.925826	0.0°	0.0°	0.0%
17	1.000000	0.540299	0.540299	0.8%	By Direction	16.0°	275.637356	-961.261696	0.0°	0.0°	0.0%

Close the PODT window with the red X in the upper right corner.

Click ✓ on the lens Property Manager to create the lens profile, which will be displayed in your sketch.

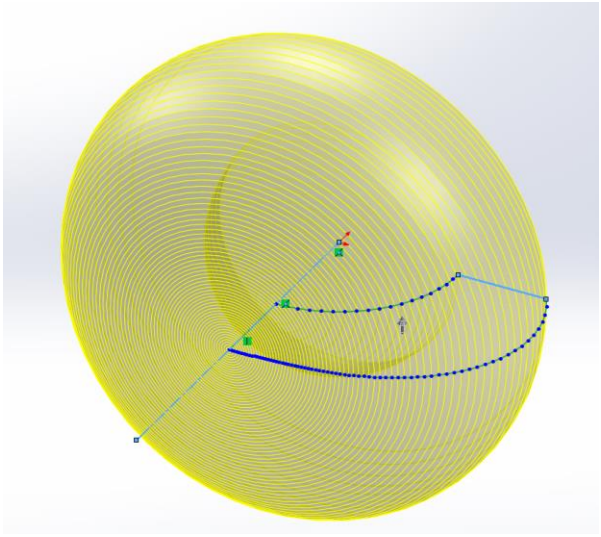


4. Create a Revolved Boss/Base Feature

Ensure the sketch is still open and click the **Revolved Boss/Base** button (Features CommandManager Tab).

Set the **Axis of Revolution** to the construction line.

The **Contour** should have automatically been populated with the PODT profile.



5. Create an Assembly and Import the LED

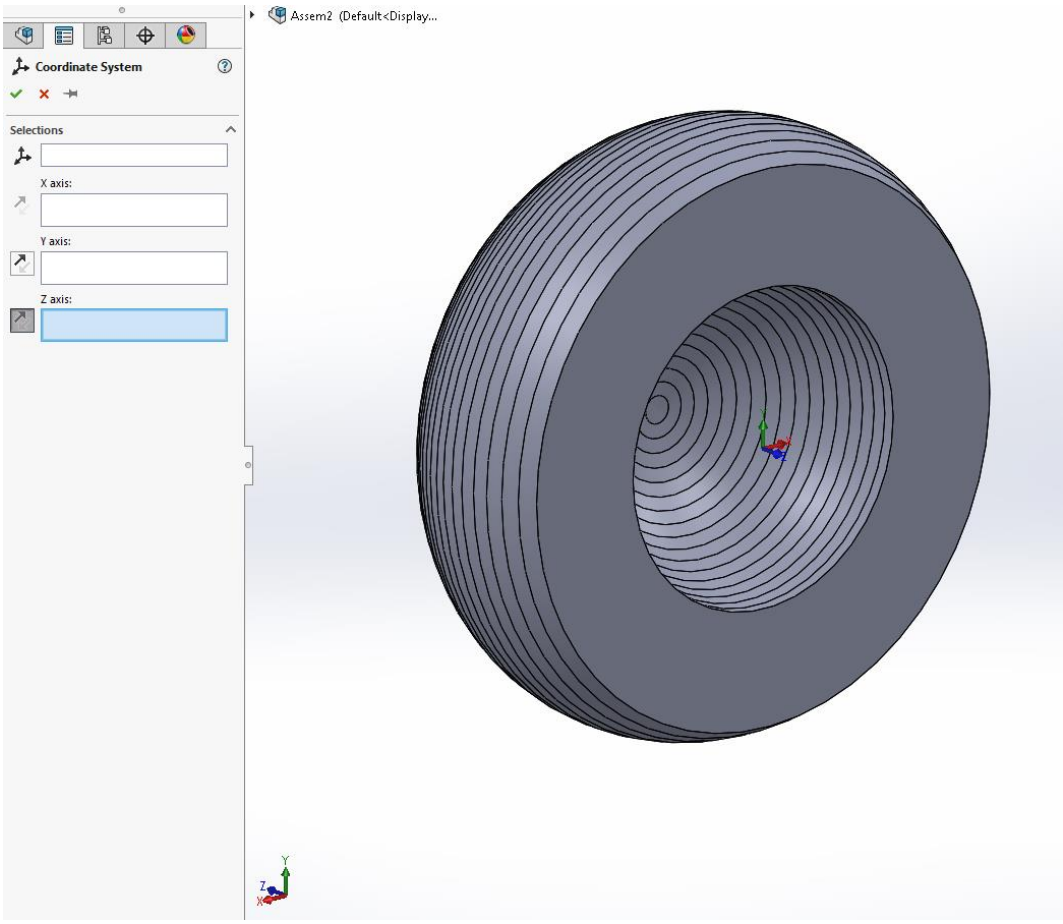
Choose **File > Save** to save the part file. Give it a name of **SW PODT Lens.**

Choose **File > Make Assembly from Part** to create an assembly file.

Choose **Insert > Reference Geometry > Coordinate System**. Click in the Z Axis reference box and then click the Arrow button to reverse the direction of the z-axis.

Click ✓ to create the coordinate system.

You should see the Z axis of the reference coordinate system point in the opposite direction of the SOLIDWORKS coordinate system in the lower left corner of the CAD view.

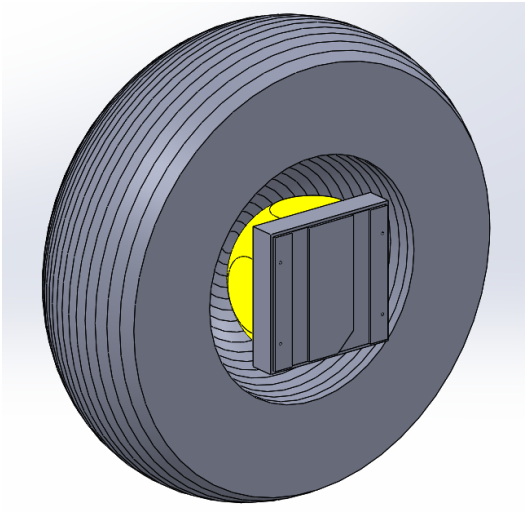


Select **Coordinate System1** in the FeatureManager and then click the **Add Lamp** button (Photopia CommandManager Tab).

Scroll down to the following lamp in the list: XP-L-5700KCORE

You will see **Coordinate System1** already referenced to this lamp model, which will ensure the lamp imports in the correct orientation.

Click ✓ to import the lamp.



6. Prepare & Run the Photometric Simulation

In the **Photopia Appearances Tab** on the right (green sphere icon), find the "Generic Acrylic 1" refractive material. Use the filter to show only the Refractive materials so you choose the right one.

Drag this material onto the Len Part in the Feature Manager to assign the material at the component level to the entire part.

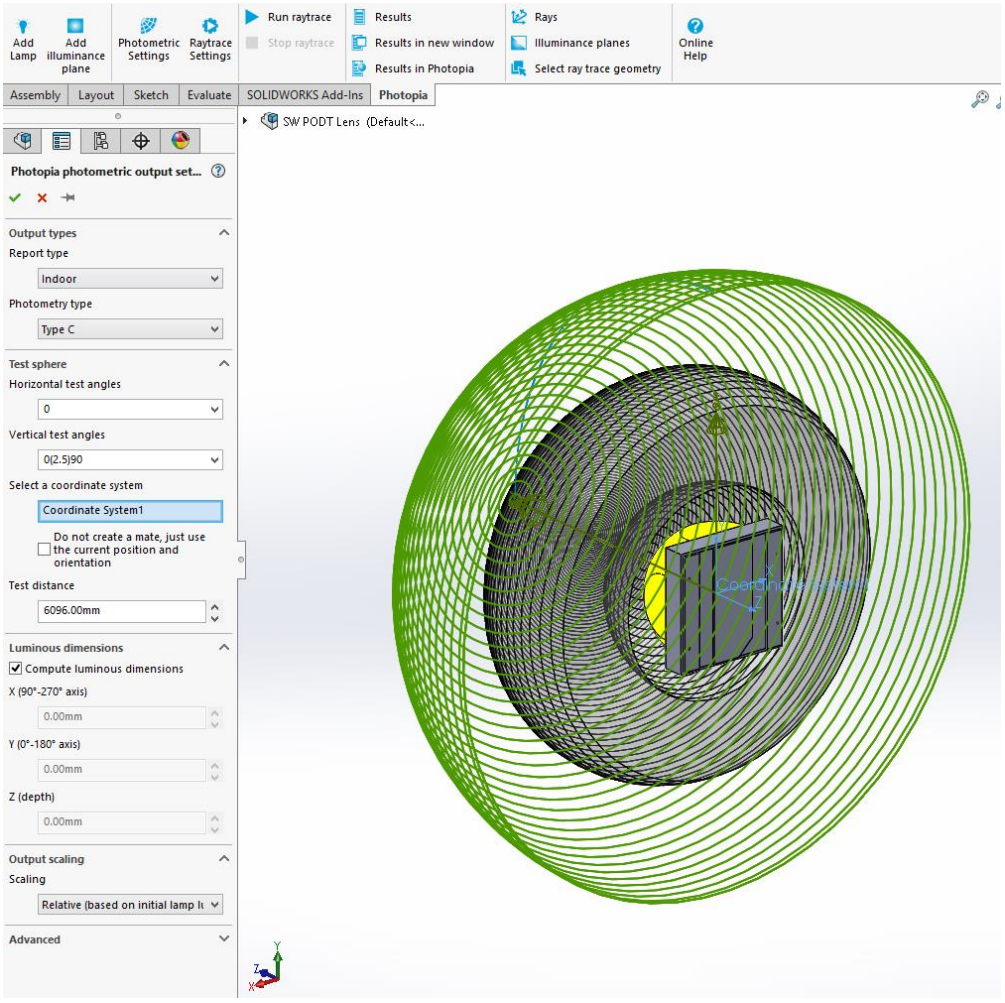
Select **Coordinate System 1** in the Feature Manager and then click the **Photometric Settings** button (Photopia CommandManager Tab).

Set the **Horizontal test angles** to: 0.

Set the **Vertical test angles** to: 0(2.5)90.

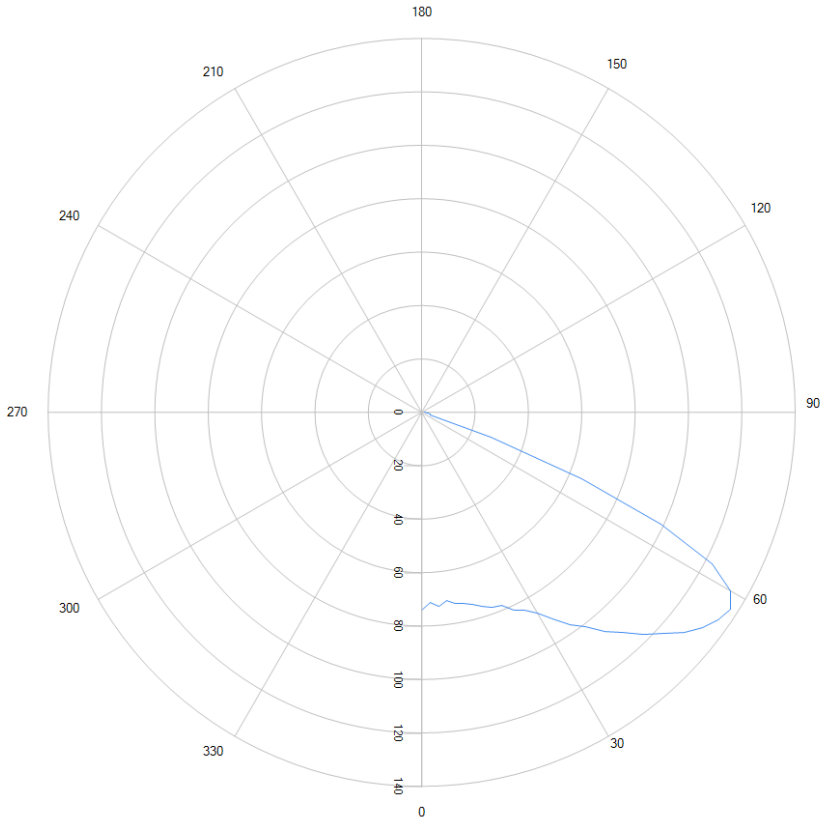
Click ✓ save the Photometric Settings.

Click the **Start Raytrace** button (Photopia CommandManager Tab) to begin the raytrace.



7. Review the Results

After the raytrace is complete, you should get a candela distribution that looks like the following:



The results for this initial lens produce a peak below 60° and more light than desired in the center of the beam. Since we were targeting a 65° peak and a higher ratio between the peak and center beam intensity, we will now adjust the lens profile.

8. Modifying the Lens

Right click on the **SW PODT Lens** in the Feature Manager and select **Edit Part** from the flyout menu.

Select the **Revolve1** feature and then click the **Design lens** button (Photopia CommandManager Tab).

Under **Reload Lens**, click the drop down list and choose the last item in the list. This will associate your initial lens parameters with the revolved boss/base feature.

Click the **Open PODT window** button.

Set the **Number of Prism Steps** to 100. This will create a smoother lens profile.

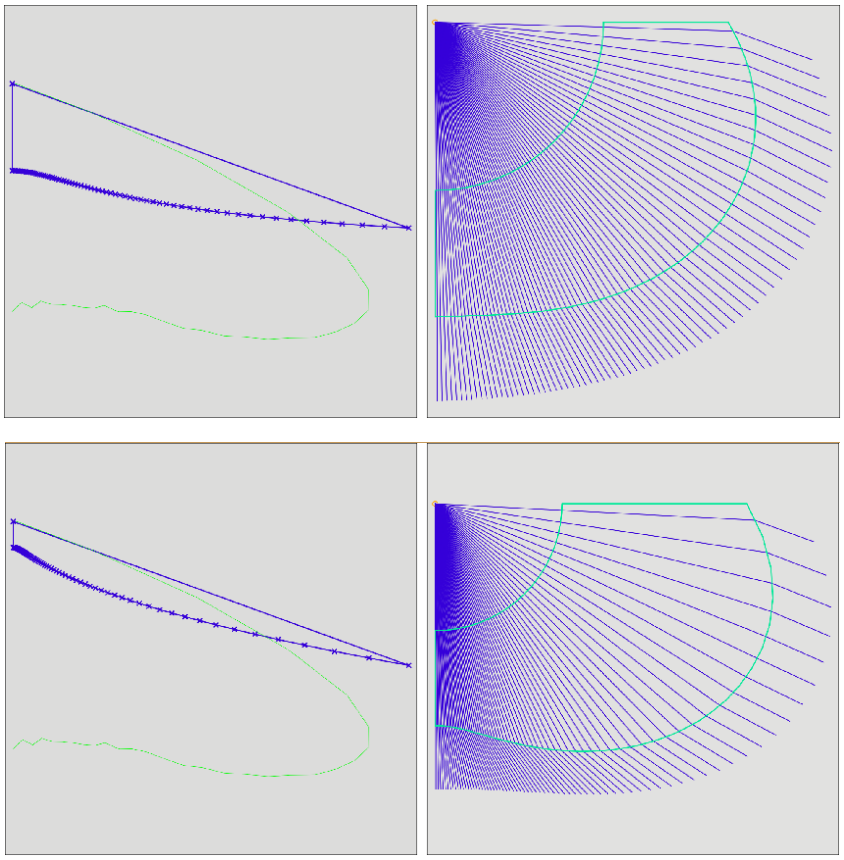
Set the **Weight exponent** to 2. This will increase the amount of light at the high angles.

Weighting Factors

The Weighting Factors (WF) determine the relative importance of each lens aiming section. A higher weight means more of the lens angular extent will be aimed toward that angle. Increasing the WF exponent generally creates higher WF's at wider angles in the beam. A negative WF exponent creates higher weights in the beam center, with a stronger emphasis at 0° the more negative the exponent. See chapter 4 in the Photopia User's Guide for a more complete explanation of the WF equation.

The images below show the blue weighting factor plot with the original exponent of 1 and the new value of 2.

The obtained candela plot from the last run is also shown in this view. The higher exponent results in a new lens shape that gets wider and is dipped in the center as a higher proportion of the lens is aimed toward the wider angles.



Close this screen

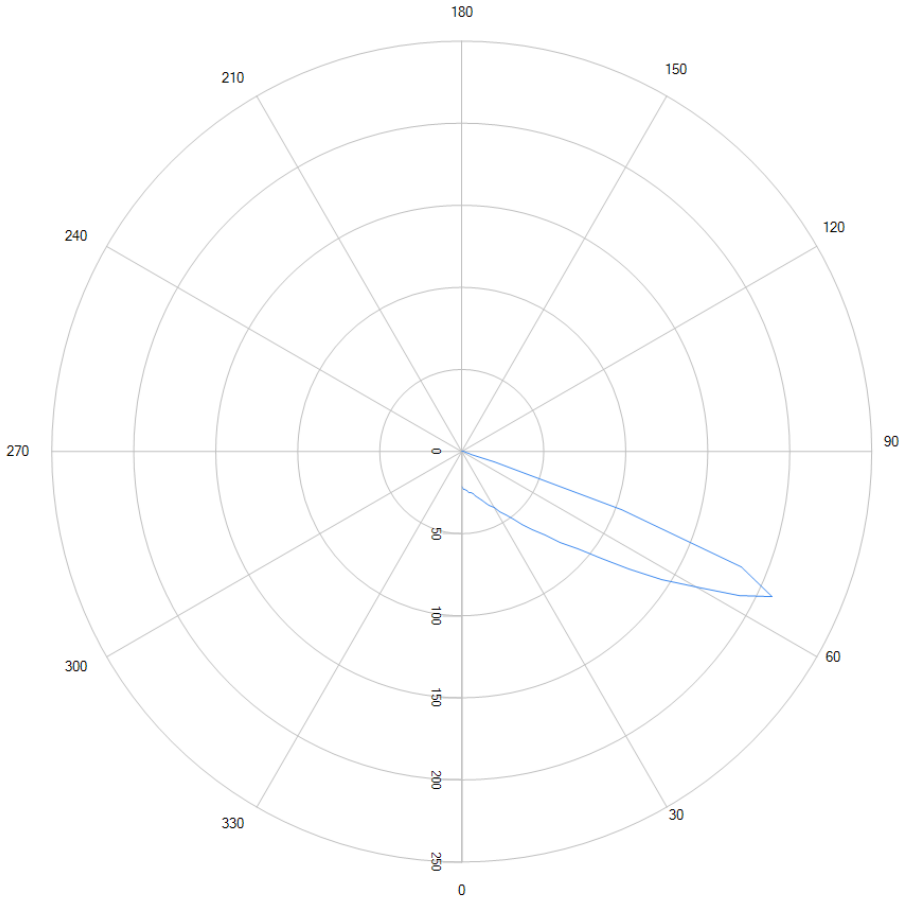
Click the ✓ to update the lens.

9. Rerun the Raytrace

Exit the part edit mode and return to the assembly.

Run the simulation again.

You should now see a beam with the following distribution that has a 65° peak beam angle with a peak intensity over 9 times the value at nadir.



10. Complete

CONGRATULATIONS! You have completed the PODT lens design tutorial.

Suggested Next Steps:

- Design a new lens with your own beam requirements
- Review the documentation at http://www.ltioptics.com/SWSupport