User's Guide

TI-OptiSim

ABSTRACT

OptiSim is a web-based optical ray tracing simulation tool supporting all TI ambient light and color sensors. This simulator enables users to import existing optomechanical designs and evaluate key sensor performance metrics such as the angular response and field of view. The tool supports complex optical stack-up configurations with multiple layers, variable aperture sizes, cover glass, and light pipes with customizable refractive indices. OptiSim lets users define these parameters for each layer and then simulate the system response, making it a useful tool for evaluating performance before prototyping a design. The purpose of this user's guide is to go over some of the key features of OptiSim, and to help users get started with simulating their design.

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1 Introduction

Ambient light sensors (ALS) and ambient color sensors (ACS) are devices that output a signal proportional to the amount of visible light incident upon the sensing area. When integrating these sensors into product designs, engineers must carefully consider how the entire optical system affects light transmission to ensure accurate measurements across varying conditions. Most product designs require housing the sensor within an enclosure for both protection and aesthetic purposes, as shown in Figure 1-1. However, the physical dimensions and configuration of these enclosures can significantly impact overall optical performance by restricting light paths and altering the sensor's response characteristics.

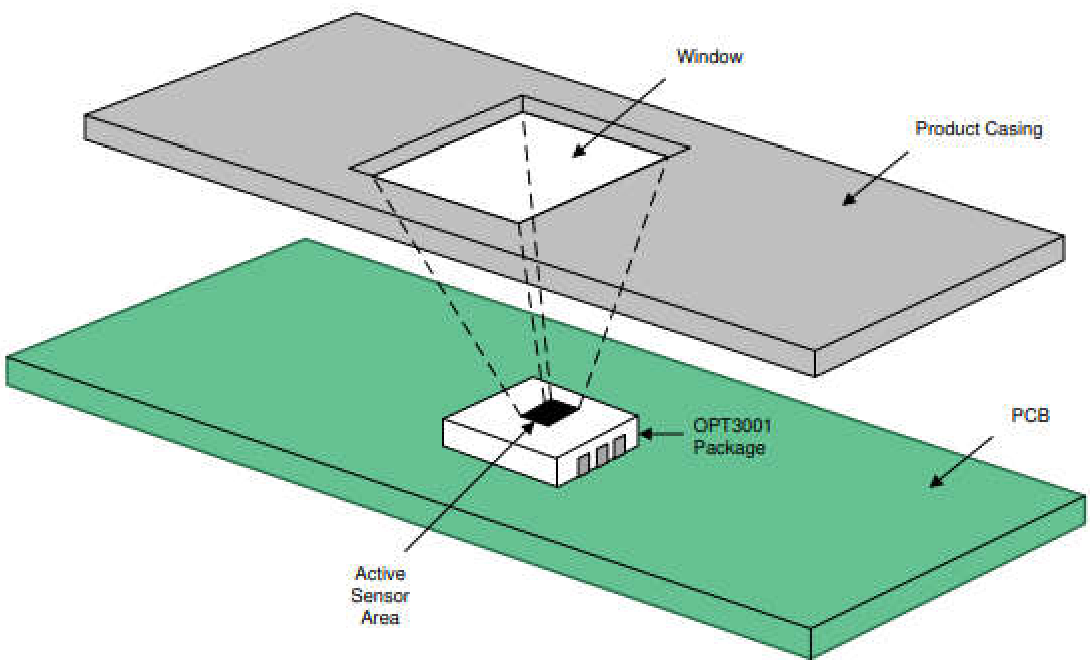

Figure 1-1. Sensor Behind Product Casing

In addition to enclosures, designers can choose to include optical materials such as light pipes and cover glass. Many applications use cover glass over sensors for various purposes - for example, dark or tinted cover glass can help conceal the sensor's appearance while still allowing the necessary light transmission for proper operation. This approach maintains the aesthetic design of the product while preserving sensor functionality.

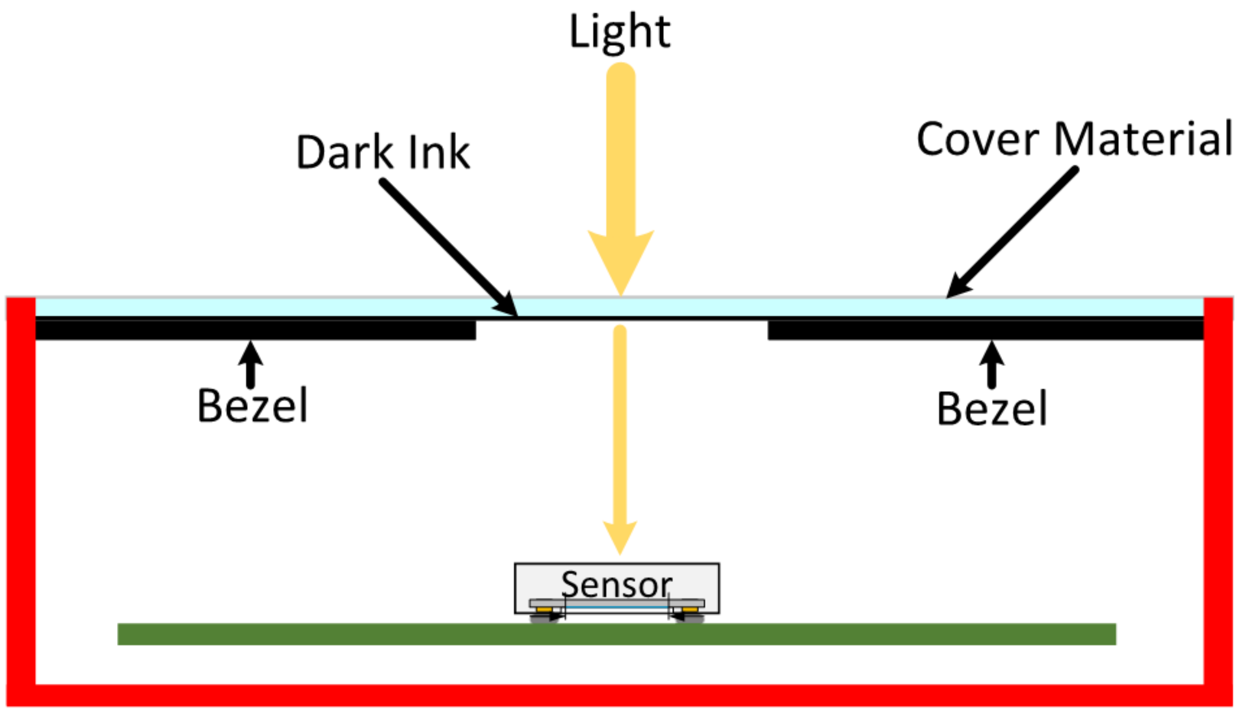

Figure 1-2. Dark Cover Glass

In instances where the sensor needs to placed deeper within an enclosure, designers can also use light pipes to extend the sensor FOV, as shown in Figure 1-3.

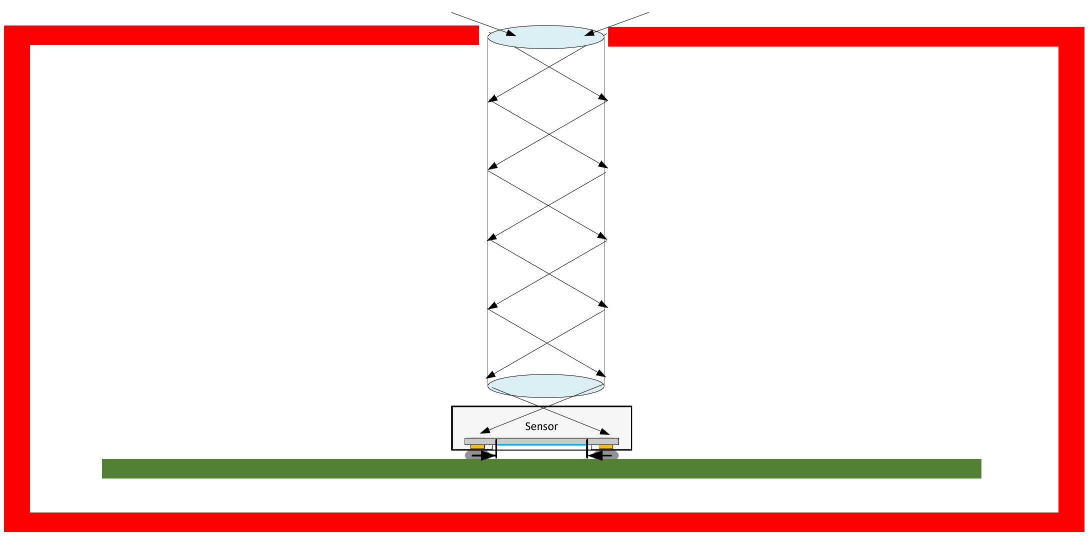

Figure 1-3. Light Pipe

For complex assemblies, designers might have several layers with window openings, a light pipe, and a diffuser all in the same industrial design to achieve both functional and aesthetic goals. The TI OptiSim tool provides a comprehensive simulation environment that allows designers to evaluate how their complete optical stack-up affects sensor performance. By specifying enclosure dimensions, aperture configurations, and various optical materials, users can accurately model their system's optical characteristics—including angular response and field of view (FOV). This capability enables informed design decisions without requiring physical prototypes or complex simulation software expertise.

2 Quick Start Guide

This quick start guide goes over all the necessary features the user needs to be aware of to quickly start a new simulation. More in-depth explanations of all the features are covered in Section 3 through Section 5.

Upon opening the tool you will be greeted with the TI OptiSim home screen (see Figure 2-1). In the home screen, users can open a new design for any of the device package options (DTS, DNP, YMF, YMN), or import an existing design.

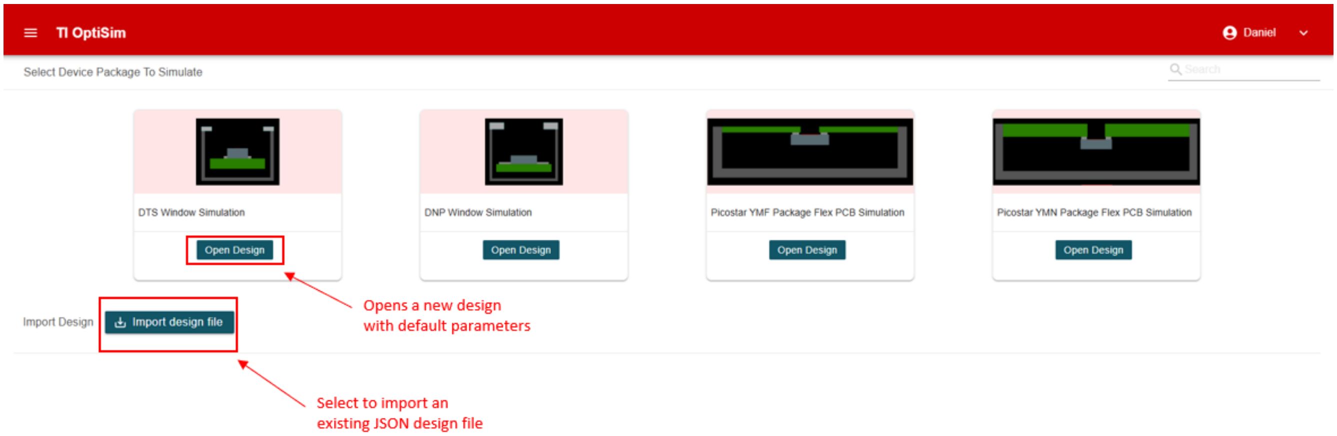

Figure 2-1. Opening a Design

Once the user have started a new design, there is a new screen showing a 2D cross-sectional view of the device on the left and a configuration panel on the right (see Figure 2-2). In the configuration panel, users can select different sensors compatible with the package type that was selected in the home screen. When opening a new design, there is already an existing layer prepopulated that the user can edit. The user has the ability to change layer height, aperture width, the distance above the lower layer, and the cover selection.

Figure 2-2. Design Edit Window

For multi-layer stack-ups, users can add new layers by selecting the “add layer” button. A new layer appears on the 2D cross-section view, and the properties for that layer appear on the configurations panel (see Figure 2-3). Similar to the default layer, each added layer is fully customizable.

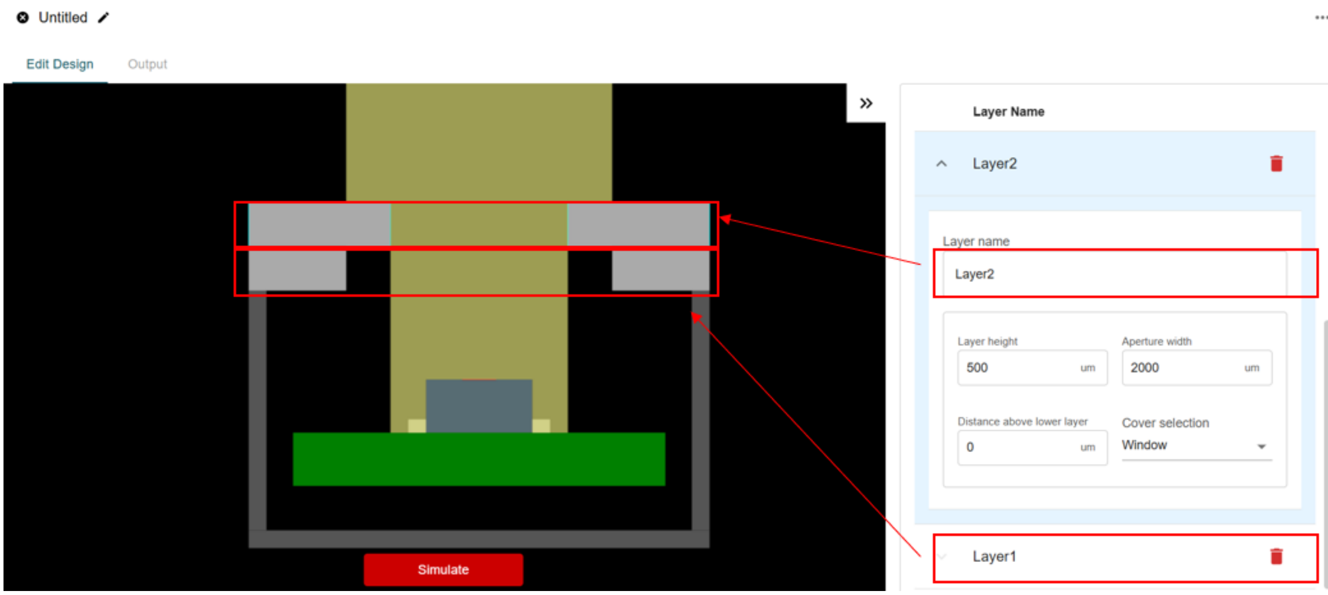

Figure 2-3. Multi-Layer Simulation

Once the edits have been finalized, users can then simulate their design by clicking the red “Simulate” button on the 2D slice window.

This generates the plot shown in Figure 2-4, showing the angular response of the sensor under the user-defined stack-up. Users can expand this window or export to CSV for further analysis.

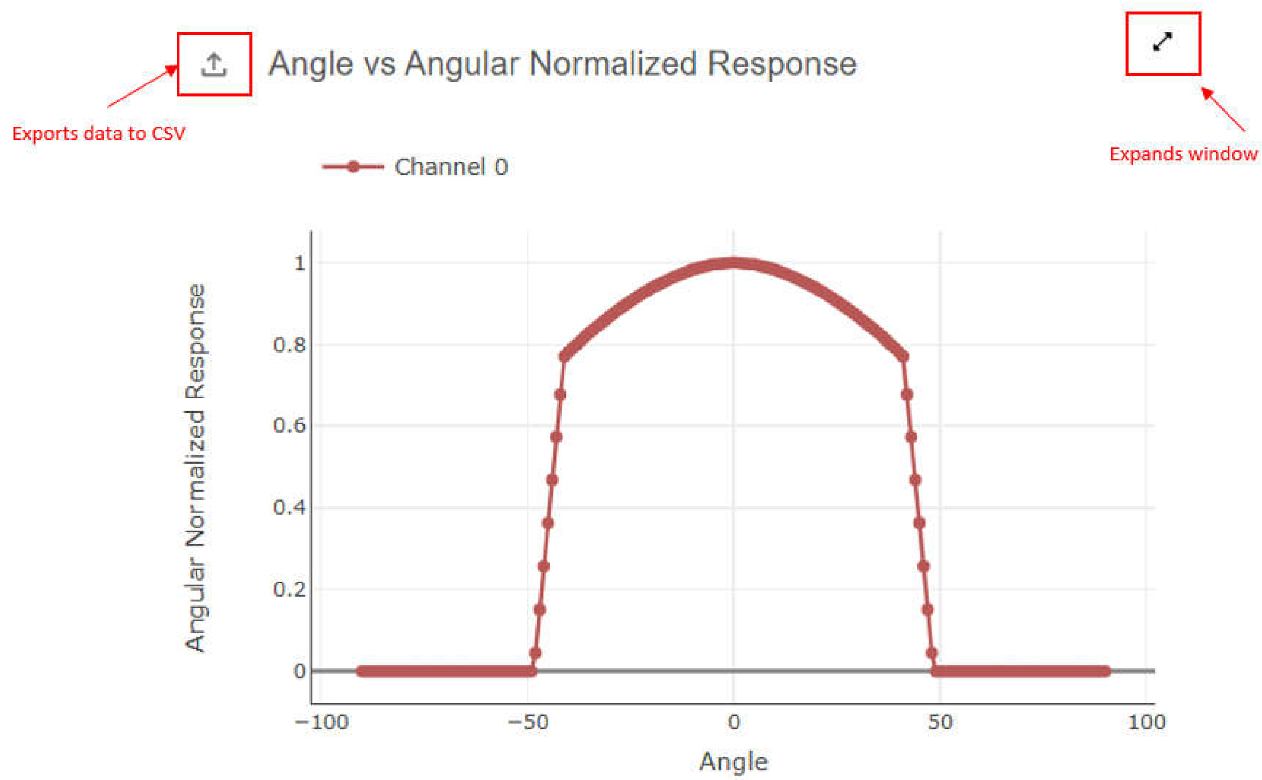

Figure 2-4. Output Plot

3 Home Screen

Upon opening the simulation tool, the user can select from one of the existing reference designs. Each of the different package types have a different design. Additionally, there is an “Import Design” button that allows the user to import a previous design, as shown in Figure 3-1.

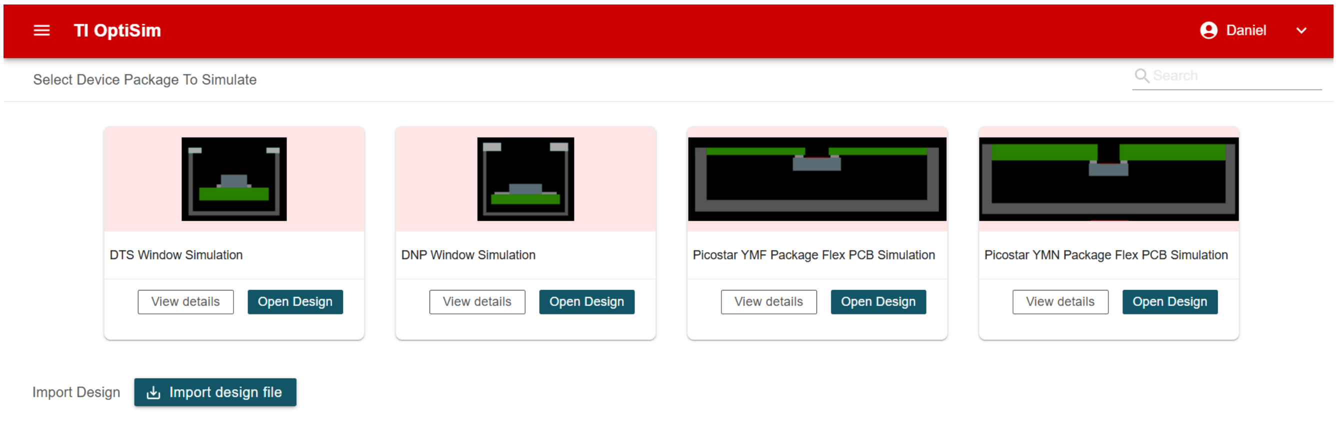

Figure 3-1. OptiSim Home Screen

In the home screen, the user can navigate to several helpful links. The navigation drop-down menu is represented by the three lines on the top left by the “TI OptiSim” title, as shown in Figure 3-2.

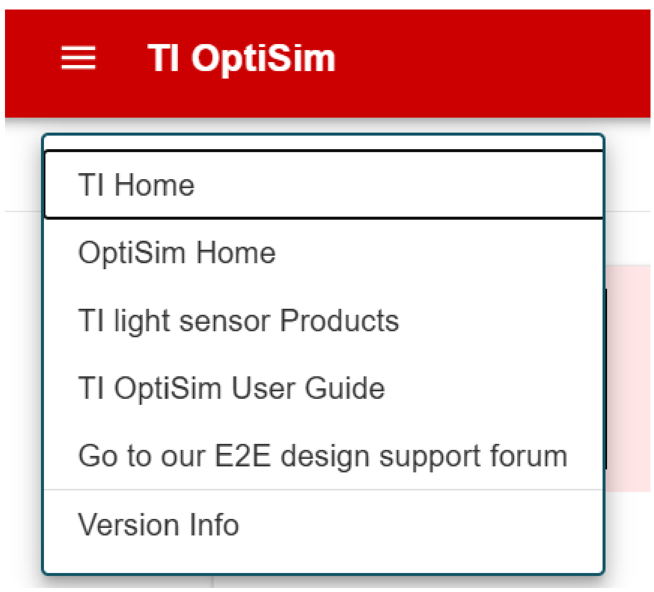

Figure 3-2. TI OptiSim Navigation Menu

4 Starting a New Simulation

Once a package type is selected, the simulation window will be displayed, as shown in Figure 4-1.

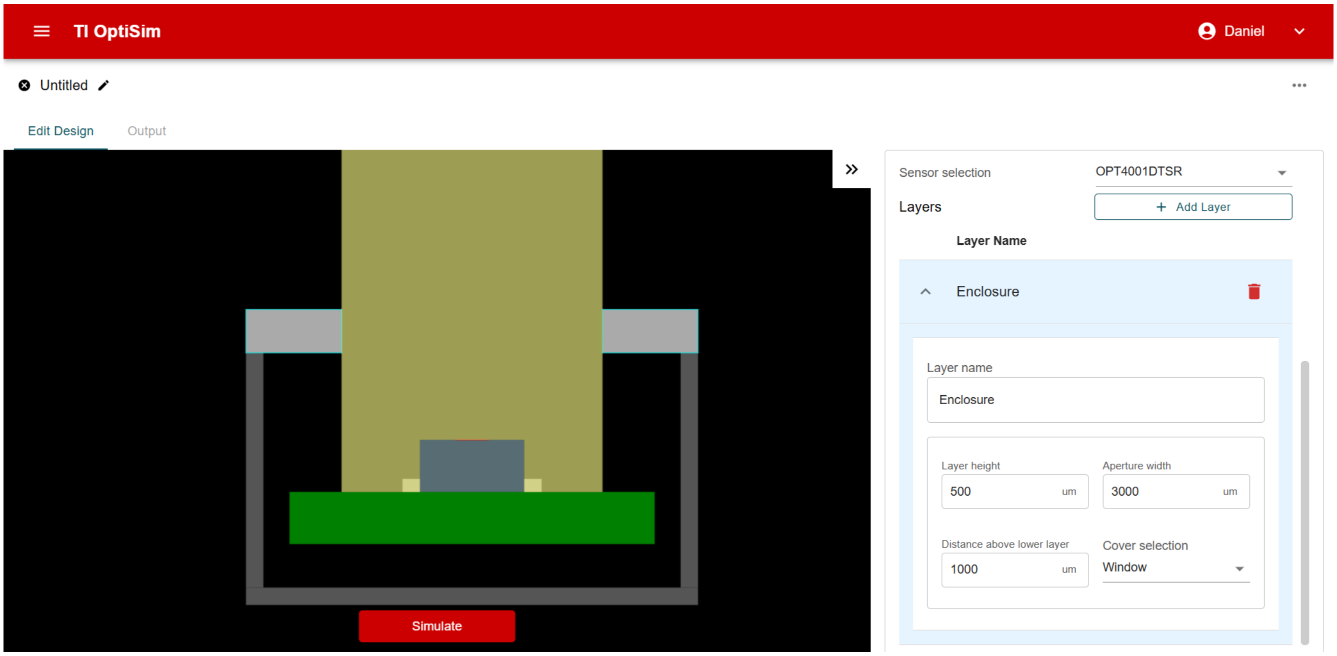

Figure 4-1. Simulation Window

Upon entering the design window, the user sees a 2D slice of the package within an enclosure and a light source. On the right side of the screen, there are several different parameters where the user can edit the design displayed to the left.

In the design edit menu, the first parameter of interest is the "Sensor selection" drop-down menu. This drop-down allows the user to select all the different optical sensors available for the selected package type, as shown in Figure 4-2.

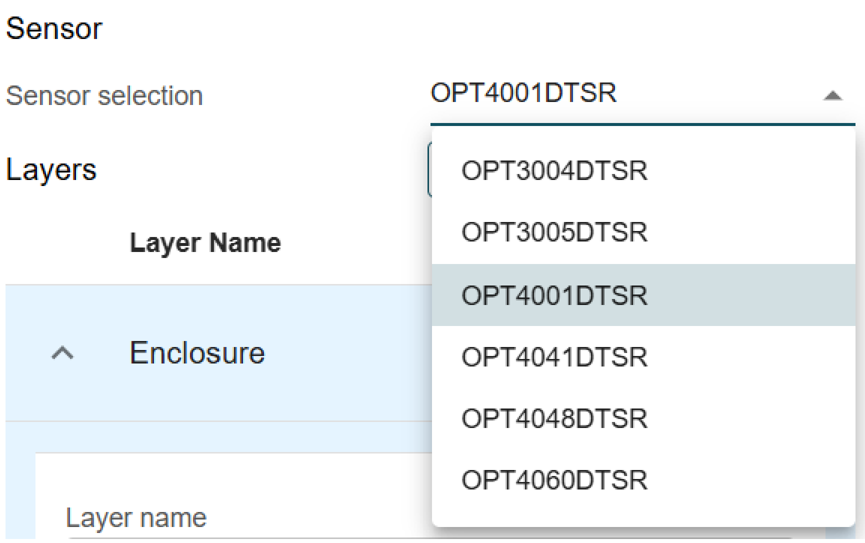

Figure 4-2. Sensor Selection Drop-Down

Below the Sensor Select Drop-down, there is a layer menu. As shown in Figure 4-3, there is already an existing layer titled "Enclosure" that already has defined properties.

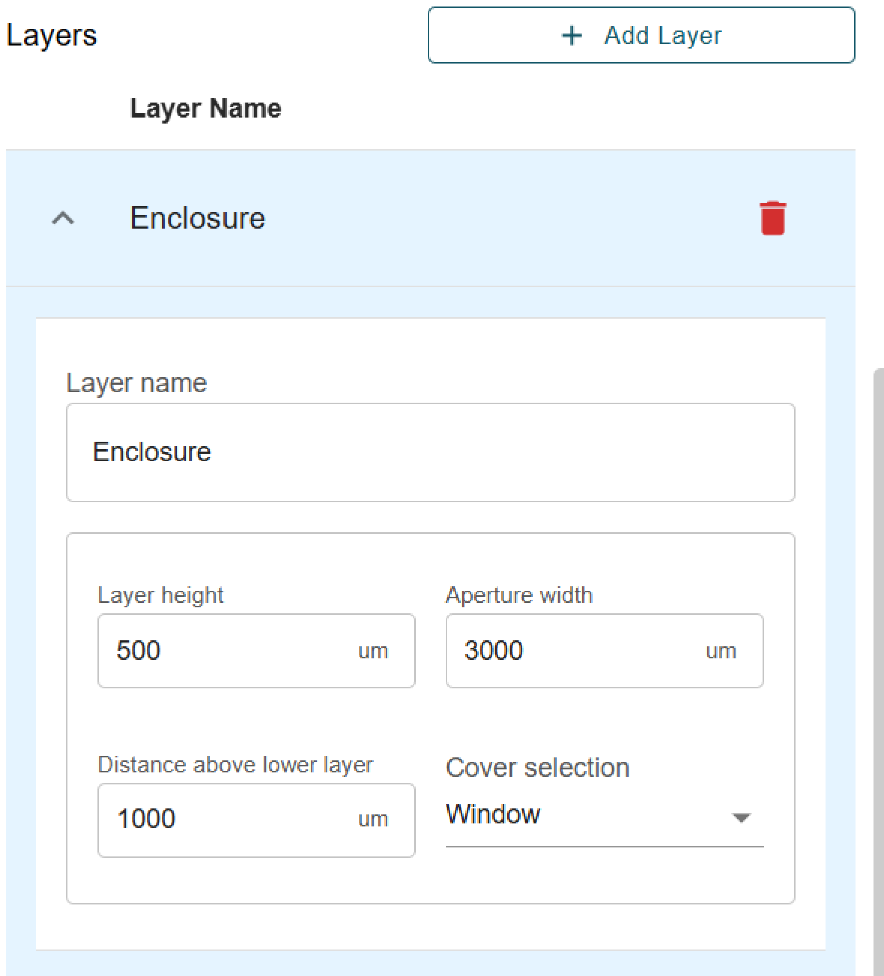

Figure 4-3. Layer Settings

This "Enclosure" layer is the light grey layer displayed in the 2D slice window, as shown in Figure 4-4.

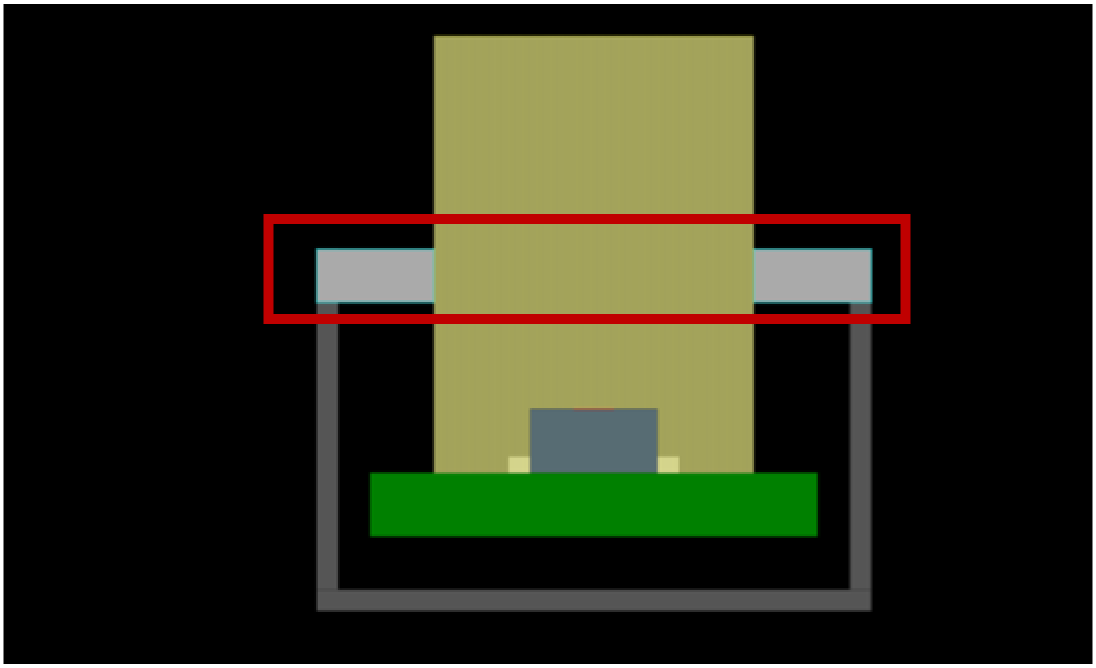

Figure 4-4. "Enclosure" Layer

In the layer settings shown in Figure 4-3, the user can edit the existing layer by changing the values of each parameter. For example, if the user wants to change the width of the enclosure hole, the user can simply enter a new value (in micrometers) in the "Aperture width" box. This will update the design immediately, as shown in Figure 4-5.

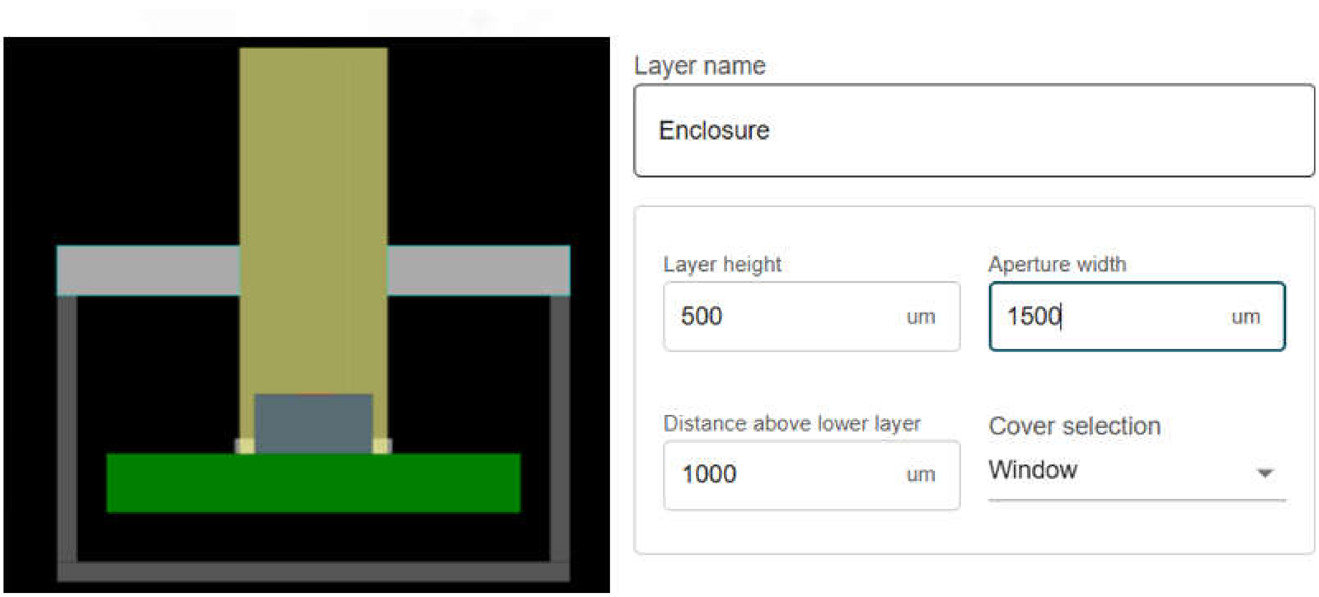

Figure 4-5. Aperture Width

In addition to the aperture width, the user can customize the height of enclosure as well as the distance of the enclosure from the sensor, as shown in Figure 4-6 and Figure 4-7.

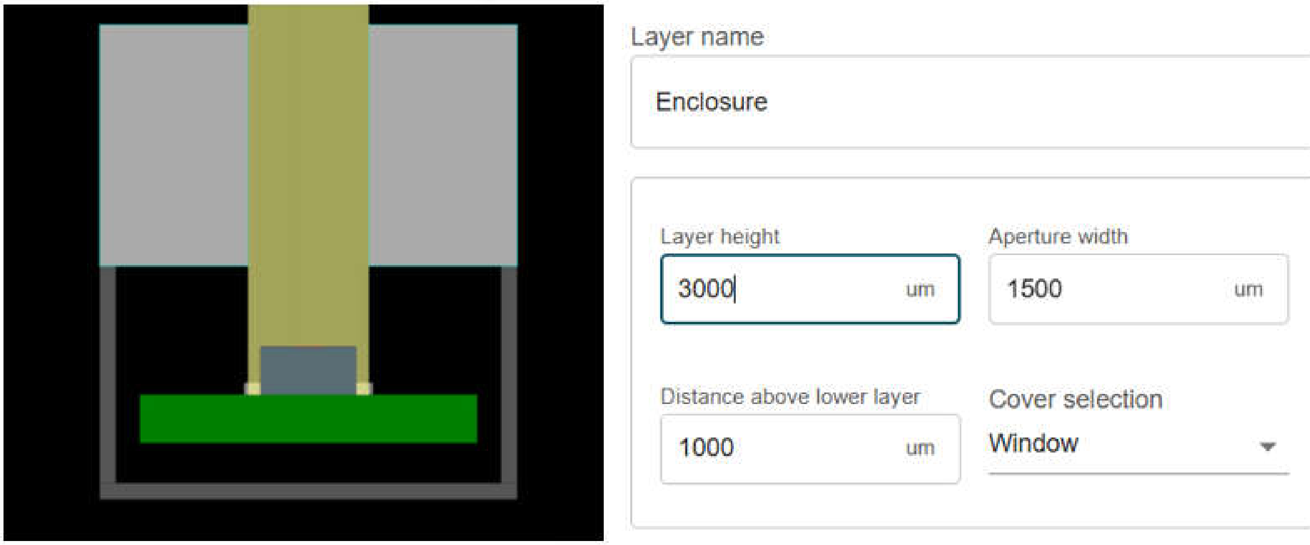

Figure 4-6. Layer Height

Figure 4-7. Distance Above Lower Layer

The final layer property that the user can change is the cover type. The user can select between a window or a dark cover/light pipe as shown in Figure 4-8.

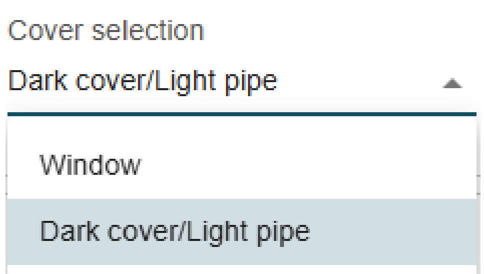

Figure 4-8. Cover Types

By default, the “Enclosure” layer is defined as a window. For window layers, the opening above the sensor is air only. When using a dark cover/light pipe layer, the aperture is filled with a glass surface with a user defined refractive index (see Figure 4-9).

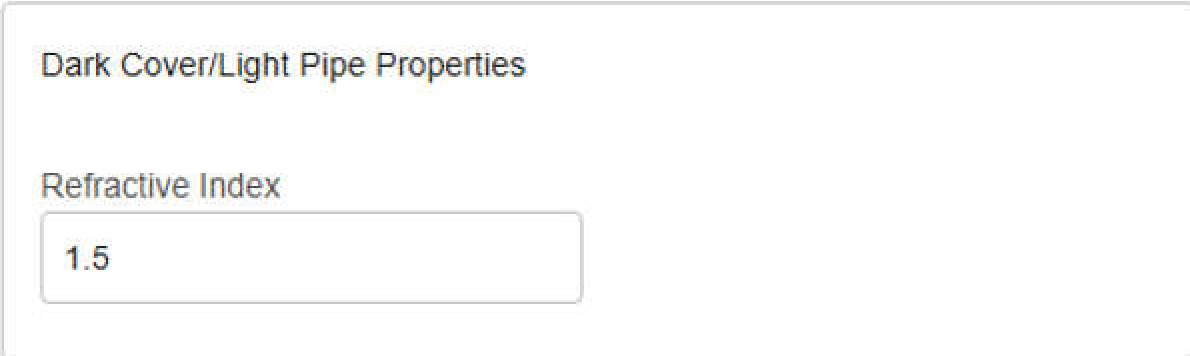

Figure 4-9. Dark Cover/Light Pipe Refractive Index

Optomechanical systems may consist of more than one layer. For example, a dark cover placed over a window or light pipe. There can be several layers of adhesive or bonding materials, spacers, or mounting features that can affect the sensor’s field of view. The user has the ability to add layers for these kinds of designs by clicking the “Add Layer” button, shown in Figure 4-10.

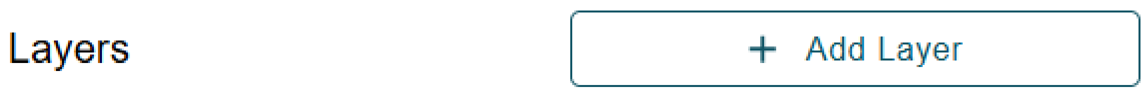

Figure 4-10. Add Layer Button

Each layer has the same properties that the user can customize. For example, Figure 4-11 shows a stack-up consisting of a dark cover and a light pipe.

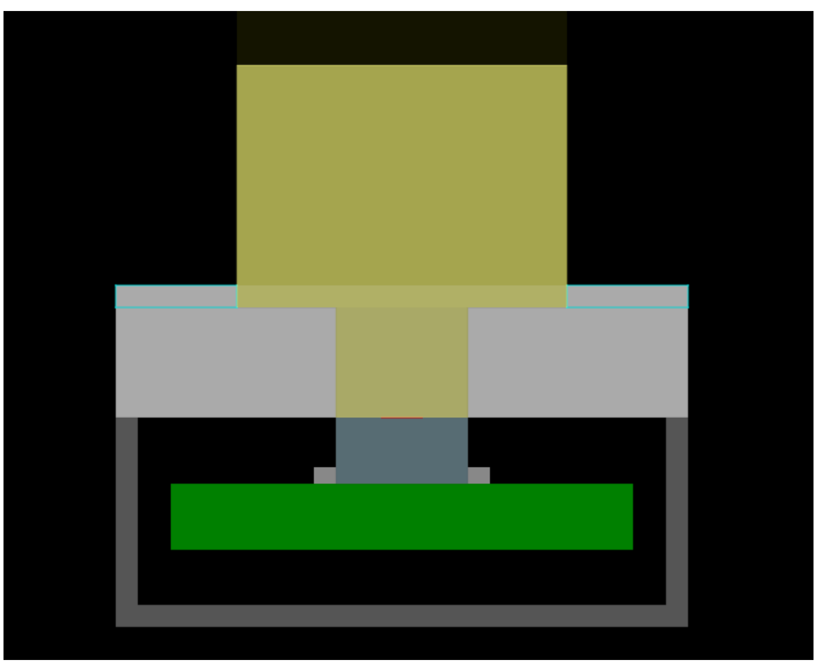

Figure 4-11. Example Stack-up

Figure 4-12. Cover Glass Layer

Figure 4-13. Light Pipe Layer

The tool allows the user to name a design by clicking the box on the top left under the "TI OptiSim" title, as shown in Figure 4-14.

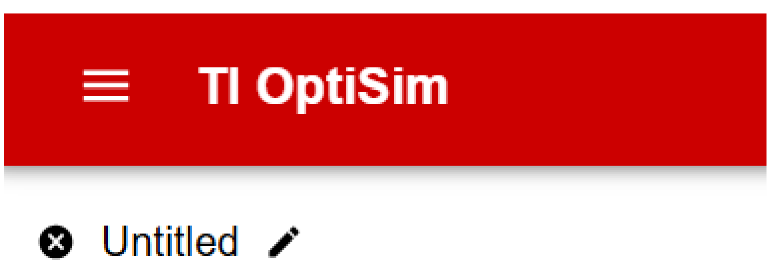

Figure 4-14. Name Design

On the top right of Figure 4-15, the user can then choose to save this design to JSON by selecting the three dots under the user's name.

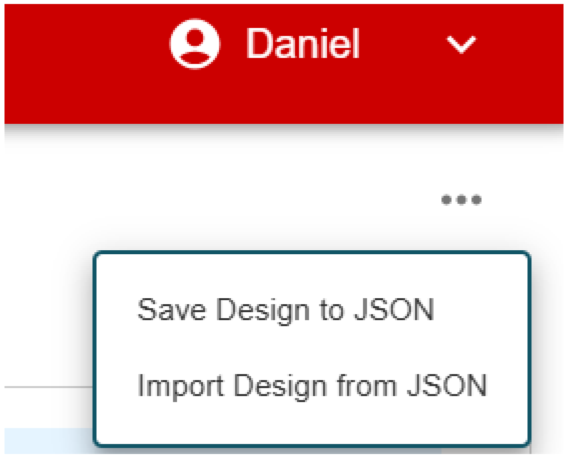

Figure 4-15. Save and Import Design

5 Running the Simulations and Outputs

Once a design has been created or imported, the user can now simulate the design by selecting the red "Simulate" button at the bottom of the 2D slice window, as shown in Figure 5-1.

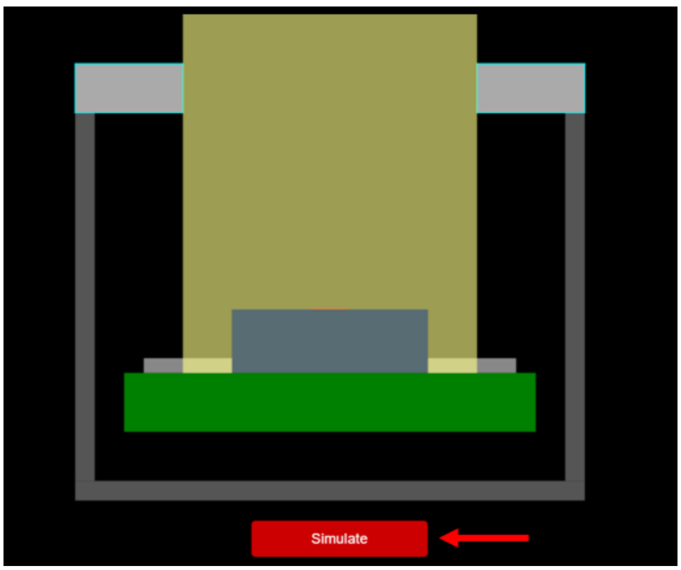

Figure 5-1. Simulation Button

Once the user initiates the simulation, the 2D slice window displays an animation of the light source moving in an arc above the sensor. The light source sweeps from -90 degrees to +90 degrees, and the amount of light illuminating the sensor area for each angle of incidence is logged in the background. Once the simulation is complete, the angular response graph is displayed to the right side of the simulation window, as shown in Figure 5-2.

Figure 5-2. Angular Response Plot

On the top right of the plot window, the user can expand the plot as shown in Figure 5-3 and Figure 5-4.

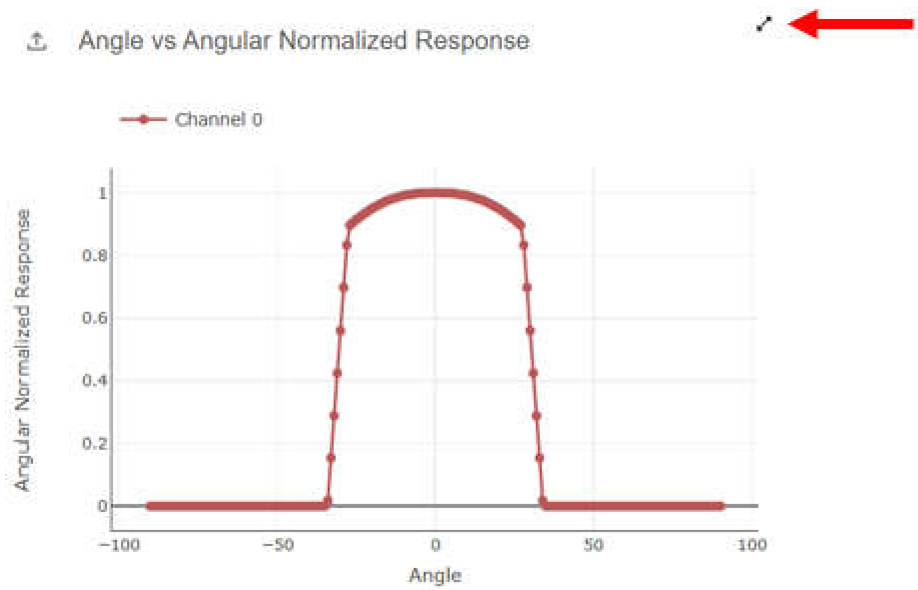

Figure 5-3. Expand Icon

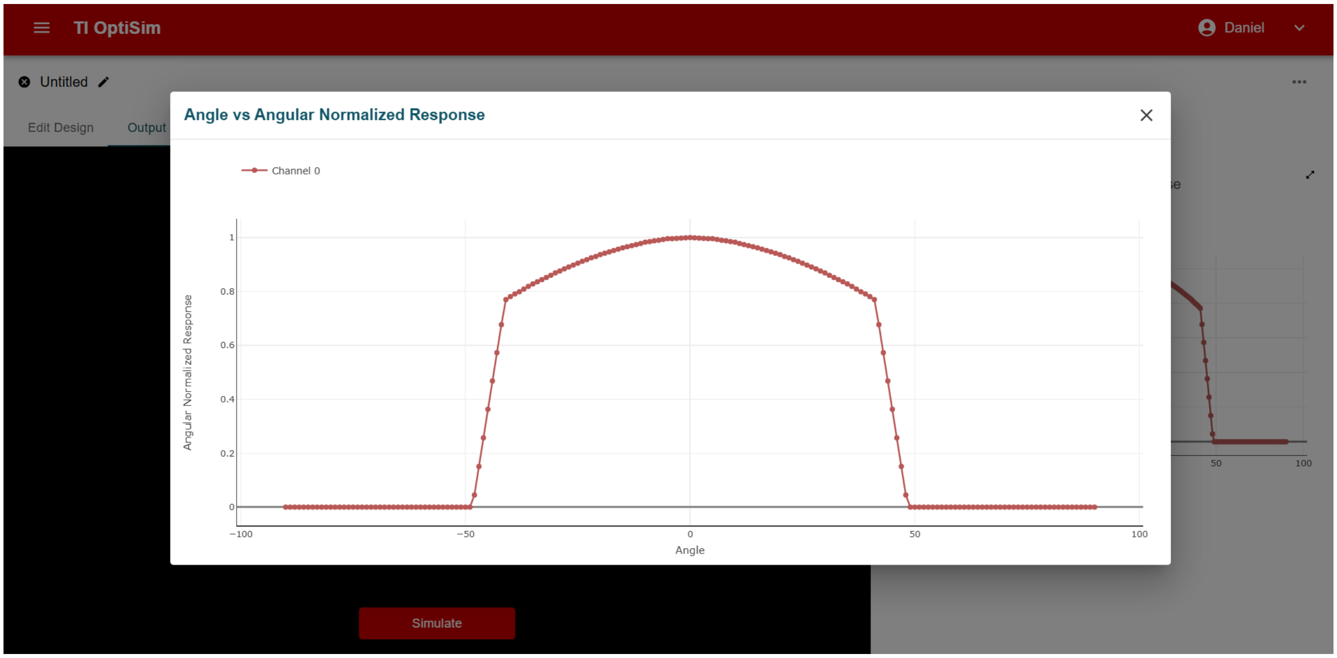

Figure 5-4. Expanded Angular Response Graph

The generated plot is interactive, meaning you can hover over the different angles and view the sensor response, as shown in Figure 5-5.

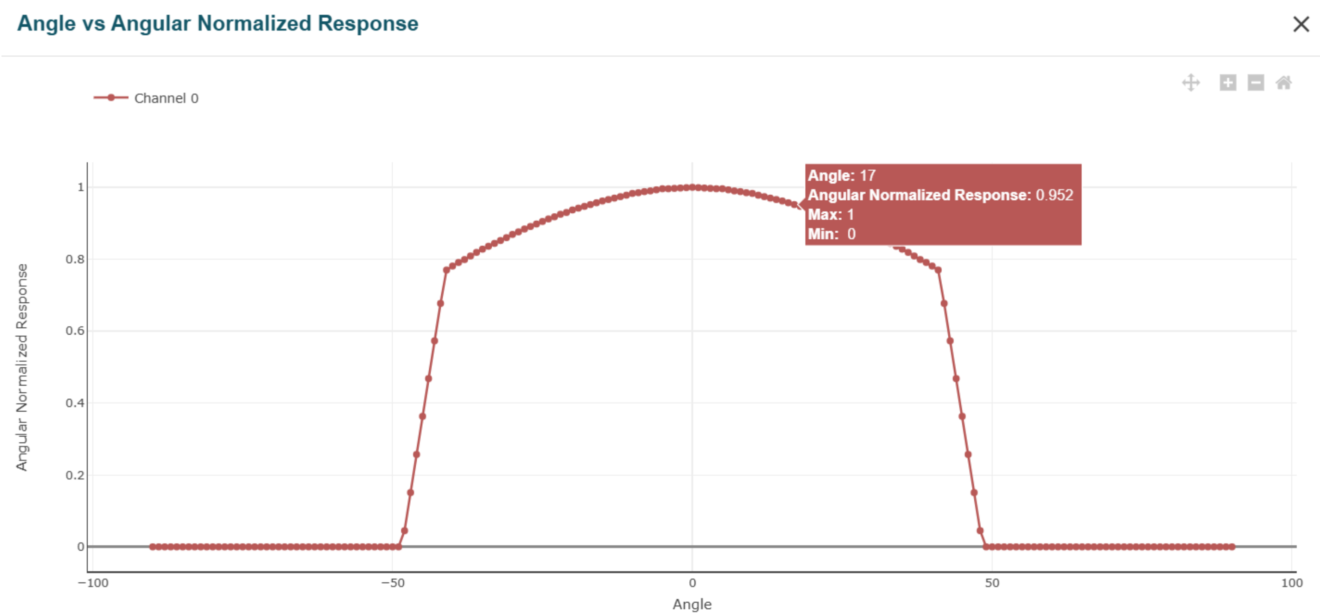

Figure 5-5. Plot Hover Feature

For multi-channel sensors like the OPT4048 (XYZ sensor) and the OPT4003 (ALS + IR sensor), the plot contains the angular response for all channels. Figure 5-6 and Figure 5-7 depicts the angular response of a 4-channel and 2-channel sensor, respectively.

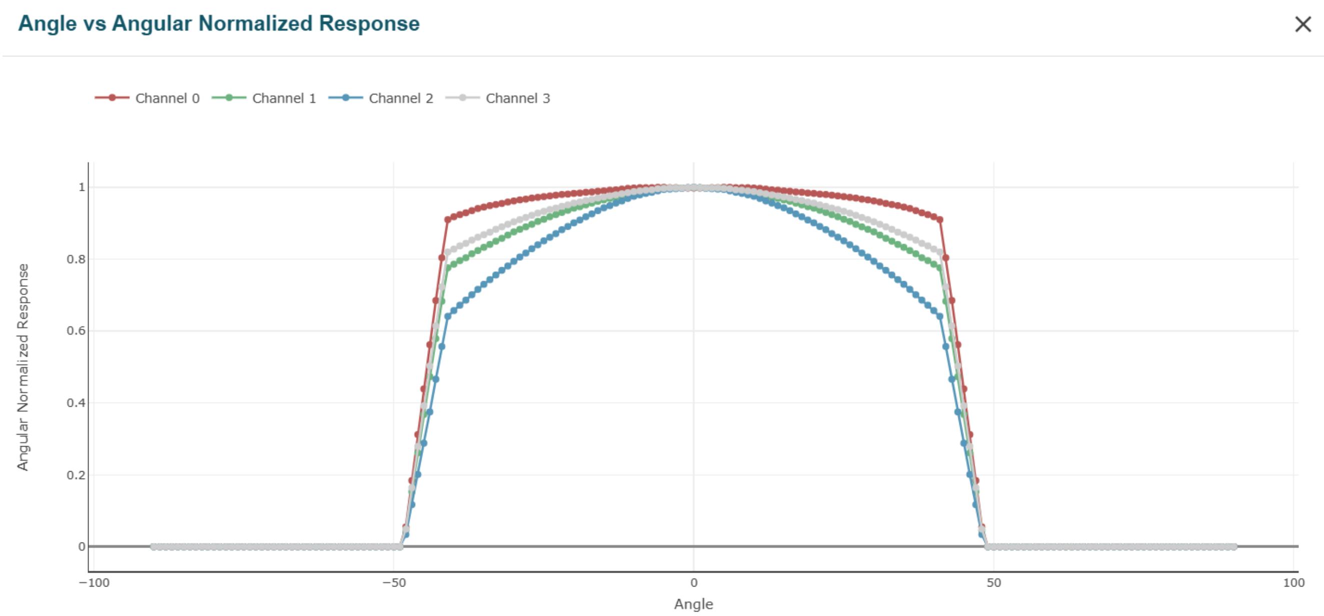

Figure 5-6. 4-Channel Color Sensor Angular Response

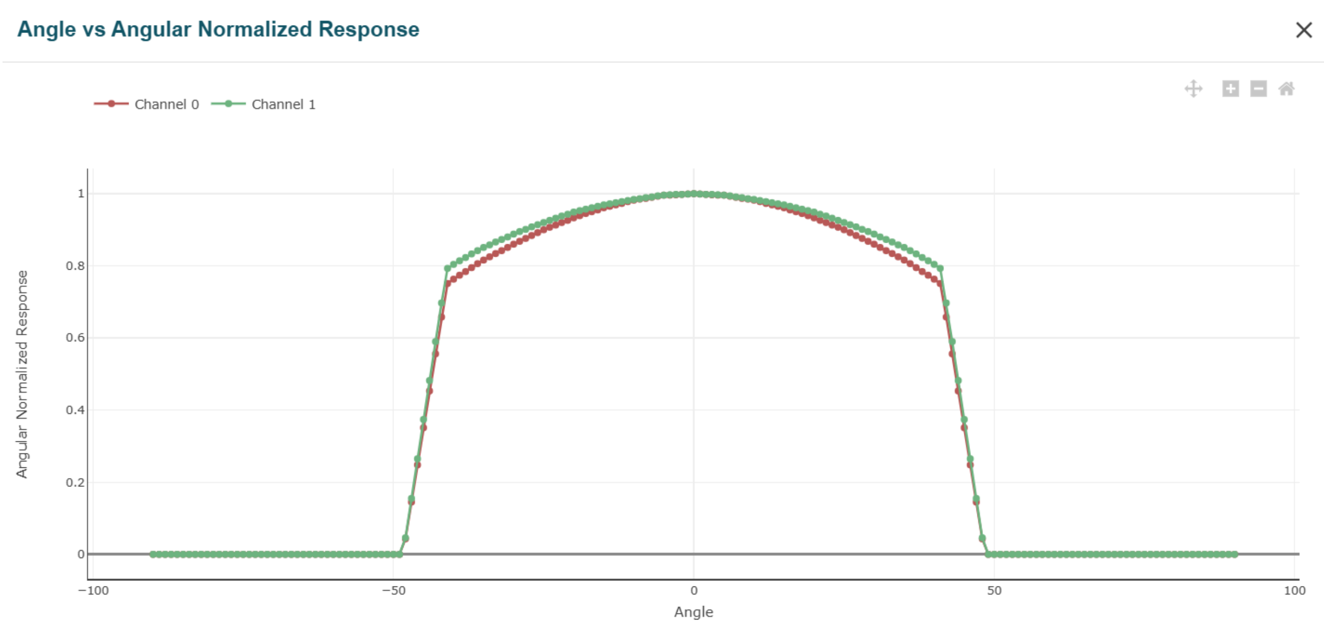

Figure 5-7. 2-Channel Sensor Angular Response

For further analysis, users can export the different plot points in excel format by selecting the “export” button on the top left of the plot window (see Figure 5-8).

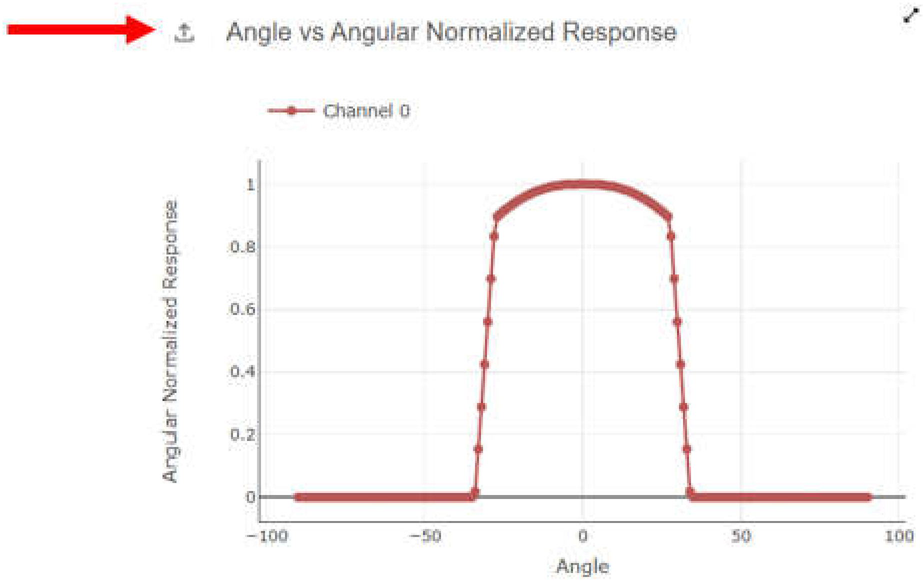

Figure 5-8. Export Button