OptisWorks Light
Modeling
2014 SP1
www.OPTIS-WORLD.com
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Introduction

Version of the SolidWorks Files Used in the OptisWorks Studio Projects
- OptisWorks Studio 2013 relies on SolidWorks OEM 2013 files.
- OptisWorks Studio 2013 SP1 relies on SolidWorks OEM 2013 SP1 files.
- OptisWorks Studio 2013 SP2 relies on SolidWorks OEM 2013 SP3 files.
- OptisWorks Studio 2013 SP3 relies on SolidWorks OEM 2013 SP3 files.
- OptisWorks Studio 2014 relies on SolidWorks OEM 2014 files.

Documentation Language
The technical documentation automatically appears in the same language than SolidWorks.

Today, the technical documentation appears in English for all the selected languages.

Multi-Threading

OptisWorks is able to run with many threads (direct and inverse simulations).
In the general options, it is possible to enter the number of threads used for the simulation.

By default, an automatic detection of the number of threads of the computer is done.

By default, Windows applications are monothread.
It means that they use only one processor.

With multi-threading, multiple threads can exist within the context of a single process, sharing the process' resources but able to execute independently.

The power of processors and computers still continues to grow, as we are reminded by the Moore law:
- Single processors, one physical chip, include the hyper threading technology.
  It means that the physical processor is seen as 2 virtual processors.
- Multi-processors: Some computers can include more than 1 processor.
  In the past, these computers were dedicated to servers, but now they are becoming increasingly desktop computers.

Windows and the Windows applications can take advantage of this hardware.
When an application can have many virtual or physical processors, it can dispatch a long calculation on all these processors.
The application manages the cooperative access to data to avoid data incoherence.

Performance
Performance can be the following on a hyper threading processor:
- 1 thread: Gain between 5% and 15%.
  This gain comes from a different management of the progress bar, the periodic saving of maps and the simulation.
- 2 threads: Gain between 20% and 35%.
  As it is not really two physical processors and as OptisWorks manages the cooperative access to data, the gain is lower than 50%.

With a dual processor computer, the gain can be up to 70%.
The gain is more important when simulating complex systems with a lot of geometries.
The gain is very low if the system is only composed of a rectangular source.

If the system to simulate is simple, for the multithreaded simulations, none of the threads ever works at 100% and adding threads may increase the simulation time (thread management).
Check that Multithreading is Running

When running a multithreading simulation, it is possible to check the use of the processors of OptisWorks by using the Windows Task Manager:

**Without Multithreading: Number of Threads = 1**

1 thread is working at 100%.

That is why the CPU Usage is around 0%.
With Multithreading: Number of Threads = 24

24 threads are working at 100%.
That is why the CPU Usage is around 100%.

---

Managing Documents

**Saving My Specific Files (Surface Quality, Material, Spectrum)**
- Save your specific files in the same folder as the part which uses these files.

  You can use sub folders of the part folder.

  You can also use an existing folder in the library.

  Here, OptisWorks can automatically find these files when you copy your system from a computer to another one.

  Ray tracing is not working after link correction of specific files (surface quality, material, spectrum).

  You must check that all the specific files are located in a sub folder within the assembly folder.

**Copying a System from a Computer to another One**
1. Copy all the SolidWorks® files.
2. Copy all the OptisWorks files like the specific optical properties (files not in the library), the ray files (if they are used as sources) and the specific spectrum files (files not in the library).

  You must copy all these files with the same sub folders if you use sub sub folders for the coding of your system.

**Saving a System with a Different Name**
- Click File, Save As...
- To keep all the optical properties associated to the file, when saving a part or an assembly, select the Save as copy check box.

---

Extensions and Units
### Vocabulary for Photometry and Radiometry Units

<table>
<thead>
<tr>
<th>Language</th>
<th>Photometry</th>
<th>Radiometry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E (Lux)</td>
<td>I (Cd)</td>
</tr>
<tr>
<td>English</td>
<td>Illuminance</td>
<td>Intensity</td>
</tr>
<tr>
<td>French</td>
<td>Eclairement</td>
<td>Intensité</td>
</tr>
<tr>
<td>German</td>
<td>Beleuchtungsstärke</td>
<td>Lichtstärke</td>
</tr>
<tr>
<td>Italian</td>
<td>Illuminamento</td>
<td>Intensità</td>
</tr>
<tr>
<td>Japanese</td>
<td>照度</td>
<td>光度</td>
</tr>
<tr>
<td>Chinese</td>
<td>照度</td>
<td>強度</td>
</tr>
</tbody>
</table>

### Extensions

A light modeling system includes different kind of files as the part, the assembly or specific files (surface quality, ray file, material, spectrum...).

There are several specific files in the software:

<table>
<thead>
<tr>
<th>FILES</th>
<th>EXTENSIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly</td>
<td>.SLDASM</td>
</tr>
<tr>
<td>Part</td>
<td>.sldprt</td>
</tr>
<tr>
<td>Material</td>
<td>.material</td>
</tr>
<tr>
<td>Ray File</td>
<td>.ray</td>
</tr>
<tr>
<td>Spectrum File</td>
<td>.spectrum</td>
</tr>
<tr>
<td>Rendering Surface File</td>
<td>.rdr</td>
</tr>
<tr>
<td>Simple Scattering File</td>
<td>.simplescattering</td>
</tr>
<tr>
<td>Advanced Scattering File</td>
<td>.scattering</td>
</tr>
<tr>
<td>Coated File</td>
<td>.coated</td>
</tr>
<tr>
<td>Thin Lens File</td>
<td>.doe</td>
</tr>
</tbody>
</table>
OptisWorks Tools

For a Part

- Optical Design and Laser
- Editors (see page 23)
- Optical Properties
- Optical Shapes
- Labs

For an Assembly

- Detectors
- Optical Design and Laser
- Editors (see page 23)
- Optical Properties
- Simulations
- Additional Features
- 3D View
- Ray Tracing
- Labs
OptisWorks Tree

OptisWorks Tree Overview

When some modifications are made, results appear with a yellow exclamation mark to inform that update must be made.

If there is some error, you can see the explanation below the tree in the OptisWorks Status area.

The OptisWorks graphic user interface is composed of tools, of menus and of an OptisWorks tree.

This tree is different for a part or for an assembly.

OptisWorks Tree for a Part

In a part, the OptisWorks tree is composed of several parts:

- Surface quality
- Materials
- Photometric sources
- Optical Surfaces
- Part Preferences

OptisWorks Tree for an Assembly

The OptisWorks tree for an assembly is composed of four parts:

- Assembly
  List of all the optical properties:
  - 3D Textures
  - LCD Component
  - Polarization Plate
  - Surface Quality
  - Materials
  - Sources
  - Optical Surfaces
  - Detectors
  - Optical Systems
  - Default part preferences

  This part also includes the preferences of all the SolidWorks parts included in the assembly.

- Simulations
  List for the Simulations folder:
  - Simulation parameters
  - Direct simulation
  - Inverse simulation
  - Interactive simulation

- Light Expert
  List for the Light Expert folder:
  - Light Path Finder
  - Ray tracing filtering
  - Surface contribution analyzer
  - Stray Light Analysis
**Result Manager**  
List of results provided by the simulations in the Result Manager folder:
- Photometric results
- Optical results
- Laser results
- Tolerancing / Optimization results
- Interactive simulation results

**Optimization / tolerancing Parameters**  
List for the Optimization / tolerancing Parameters folder:
- Optimization / tolerancing Variables
- Optimization / tolerancing Targets
- Tolerancing
- Optimization

**Performing a Search in the Tree**
1. Right-click an item in the OptisWorks tree, and then select Go to...
2. Type a text in the Find box.
3. Click Find Next as many times as needed.
   - The tree searches from top to bottom.
4. If you want to reverse direction, clear Start from the top.
Customizing the Command Manager

1. To add a tool in the Command Manager, right-click in the Command Manager, and then select Customize...

2. In the Commands tab of the box, drag the tool that you want to view in the Command Manager to the Command Manager.
FEATURES

Optical Properties

Part Preferences

Editing the Part Preferences

You can define some preferences which are stored in each assembly or part file. For a part, you can define the tessellation and the default optical properties.

Editing the Preferences of a Single Part

1. In a part, click Part Preferences (Optical Properties).
   - The PropertyManager appears.
2. Set the parameters (see page 13).
3. Click OK.
   - Or-
1. In a part, in the OptisWorks tree, right-click Part Preferences, and then select Edit.
   - The PropertyManager appears.
2. Set the parameters (see page 13).
3. Click OK.
   - Or-
1. In an assembly, select a part in the Default part preferences folder in the OptisWorks tree, and then click Part Preferences (Optical Properties).
   - The PropertyManager appears.
2. Set the parameters (see page 13).
3. Click OK.
   - Or-
1. In an assembly, select a surface in the 3D view and right-click.
2. Select OptisWorks, Edit Part Preferences.
   - The PropertyManager appears.
3. Set the parameters (see page 13).
4. Click OK.

Editing the Preferences of Several Parts

You can apply the same optical properties to different parts at the same time.

1. In the OptisWorks tree, select the different parts to modify.
2. Right-click Part Preferences, and then select Edit.
   - The PropertyManager appears.
3. Set the parameters (see page 13).
4. Click OK.
   - The parameters you just defined are applied to all the selected parts.

Parameters of Part Preferences

For a part, you can define the default optical properties, the tessellation and the axis.
**Default Optical Properties**
In the Default Optical Properties group box, you can define the default surface quality and the materials of your system by browsing the files in the Surface quality, Internal material and External material boxes.

By clicking OptisWorks - Glass catalog you can switch from starting the glass catalog viewer in the OptisWorks - Glass catalog box.

To complete the Glass catalog, you must download a library, create a directory with the catalog name in ..\Library\Material, and then copy different materials in the new directory.

**Internal Material and External Material**
The material gives the volumic properties, the refraction index, 1 for AIR and 1.5 for PMMA for example, the volumic absorption (mass tinted plastic) and the volumic scattering (fog).
All these parameters depend on the wavelength.
For each surface, you must define the internal and the external material.
For example, if you want to define a lens of polycarbonate in the air, you must set for each surface of the lens the PC material as the internal material and the AIR material as the external material.
In most cases, you must only set the internal material to define the material of your volume.
If you do not set the external material, the default preferences are set up (AIR in most cases).
But in optic, you can have some specific components like doublet and triplet.
In these components, you have internal faces which separate two materials.

In this example, you can just set Material 1 for the internal material for the faces 1 and 4.
The default ambient material is taken as the external material.
But for the faces 2 and 3, you must set Material 2 for the internal material and Material 1 for the external material.

**Surface Quality**
When a ray hits a surface of the geometry, with setting the surface quality, you can see how the ray is reflected or refracted.
You can have many different surface qualities:
You can have an optical surface, mirror or optical polished surface.
This means that you only have a specular ray for reflection or refraction.
Gaussian or Lambertian scattering

The surface may have some absorption which gives a color to the surface. All the surface quality parameters may be different according to the wavelength.

Geometry Precision of the Tessellation

In the Geometry precision of the tessellation group box, you can define the geometry precision for the calculation kernel.

Max Facet Width (mm)

You can click Max facet width (mm), and then set a value in the spinbox. It corresponds to a maximum for the length of the facet edges of the tessellation. You must use this option with precaution. If you try to use a small value for this parameter with an assembly of a large size, this may generate a large tessellation and your computer may not have enough memory. For example, one millimeter is not appropriate with an assembly of one meter. It is better to use this option when you want to calculate a 3D map.

Deflection (mm)

You can click Deflection (mm), and then set a value in the spinbox. It corresponds to a maximum for the distance between the real surface and the facets of the tessellation.

Anisotropy Axis

In the Anisotropy axis box, you can define the axis system of a gradient index material (axial model) or a three axes birefringent material only.

There are two ways to define the axes of birefringent materials:

- By using the anisotropy axis definition to avoid creating one material per axis system.
- By leaving the anisotropy axis definition blank. The default axis system (Ox, Oy, Oz) is then used by the birefringent materials.

Editing the Default Part Optical Preferences

No file must be open.

By default, the default part preferences files are the Optical_Polished for the surface quality, the PMMA for the internal material and the Air for the external material.

1. Click the OptisWorks menu, Default Part Optical Preferences...
   The Default Part Optical Preferences box appears.
2. Browse the files in the Surface quality, Internal material and External material boxes.
3. Click OK.
Tessellation

Displaying a Tessellation

You can display a tessellation in a part or in an assembly.

1. Click Tessellation Display (3D View).
   
   The tessellation appears.

2. If you want to hide the tessellation, click Tessellation Display (3D View).
   
   You can set the tessellation parameters in the parameters of part preferences (see page 13).

Updating a Tessellation

You can update a tessellation in a part or in an assembly.

- Click Tessellation Update (3D View).
Face Optical Properties

Setting a Surface Quality

Setting a surface quality can only be done in a part.

With this function, you can apply a surface quality to one or more selected faces only.

You can set a surface quality to any face.

1. Click Surface Quality (Optical Properties).
   The PropertyManager appears.
2. To select the faces that you want to modify, click them in the graphics area.
3. In the Surface quality box, browse a surface quality from the library.
   The Transparent surface is used to remove surfaces from the photometric model.
   For more details you can view Tangent Surface Management (see page 18).
4. Click OK.
   All the surface qualities set appear in the OptisWorks tree.
5. If you want to edit or remove the surface, right-click it in the OptisWorks tree, and then select Edit or Remove And Sets to Default.

Under each surface quality item, you can see the name of the parts in which they are applied.
You can double-click the part to open it or you can right-click it to display a shortcut menu.

Setting an Internal Material

Setting an internal material can only be done in a part.

With this function, you can apply an internal material to one or more selected faces only.

You can set a material to any face.

1. Click Internal Material (Optical Properties).
   The PropertyManager appears.
2. To select the faces that you want to modify, click them in the graphics area.
3. In the Internal Material box, browse a default material from the Library folder or a file you have created (.material files).
   All material which is set appears in the OptisWorks tree.
   Under each material item, you can see the name of the parts in which they are applied.
   You can double-click the part to open it or you can right-click it to display a shortcut menu.
   By default, the photon is emitted in the external material, unless the emission is inversed, then the photon is emitted in the internal material.
   To get a coherent system when the surface is not closed, the internal and external materials must be the same.

Setting an External Material

Setting an external material can only be done in a part.

With this function, you can apply an external material to one or more selected faces only.

1. Click External Material (Optical Properties).
   The PropertyManager appears.
2. To select the faces that you want to modify, click them in the graphics area.
3. In the External Material box, browse a default material from the Library folder or a file you have created (.material files).
All material which is set appears in the OptisWorks tree.
Under each material item, you can see the name of the parts in which they are applied.
You can double-click the part to open it or you can right-click it to display a shortcut menu.
By default, the photon is emitted in the external material, unless the emission is inversed, then the photon is emitted in the internal material.
To get a coherent system when the surface is not closed, the internal and external materials must be the same.

**Tangent Surfaces Management**

To manage tangent surfaces, you must use the transparent.transparent surface file for the surface quality and the PMMA file for the external material.

You must not use the Transparent.transparent surface on a volumic surface if you apply in the same time a 3D texture on another volumic surface.

**Why Do We Need a Transparent.transparent Surface?**

This surface is used to remove surfaces from the photometric model.
A surface with this property is not meshed and does not affect the simulations.

This is used in the following case:

- To remove one out of two tangential surfaces, an optical doublet for example.
- To remove a surface that does not affect the simulation in order to reduce the needed memory and the simulation time.

When setting this surface quality on a surface, the surface does not interact with the light.
The surface is considered completely transparent.
The path of the Transparent.transparent surface file is .../OPTIS/Library/Surface.
When two parts are tangent, the tangent surface must be defined as described in the second picture.
Example
These are two parts included in the same assembly.

To be able to edit surfaces and materials, you must open the part and click Part Preferences (Optical Properties).
After making the two parts tangential to each other, the following assembly is rebuilt.
In reality, a PMMA-POLYCARBONATE surface is required. The fact that the PMMA-Air and Air POLYCARBONATE surfaces are tangential means that some air is located between them. In the reality the information is wrong.

That is why the ray tracing is incorrect.

The solution to get only a PMMA-POLYCARBONATE surface is the following:

- Part1: You must remove the right surface by selecting the Transparent.transparent surface by using the Surface Quality tool (OptisWorks Optical Properties). You can view Setting a Surface Quality. (see page 17)
- Part2: You must upgrade the external material of the left side by selecting the PMMA material by using the External Material tool (OptisWorks Optical Properties). You can view Setting a Material (see page 17).
The Air-POLYCARBONATE surface is now replaced with the PMMA-POLYCARBONATE surface.

![Diagram of Air-POLYCARBONATE surface]

Now, the ray tracing is correct.

![Diagram showing ray tracing]

**Viewing Face Optical Properties**

*You must define Face Optical Properties to access the View Face Optical Properties feature.*

1. In an assembly or in a part, select a surface in the 3D view and right-click.
2. Select OptisWorks, View Face Optical Properties.
   - The Face Optical Properties window opens.
   - The file path of each face optical property you applied is displayed in read-only mode.
   - According to the type of face optical properties you defined, the following sections can appear:
- Surface quality.
- Internal material
- External material.

You can click the icons to edit the files in the corresponding OPTIS Lab.

Editors Icons

- Rendering Surface Quality
- Simple Scattering Surface Quality
- Advanced Scattering Surface Quality
- Coated Surface Quality
- Thin Lens Surface
- User Material Editor
Sources
Surface Source

Creating a Surface Source

A surface source can only be created in a part file.

With a surface source, you can model the light emission of a source taking into account its physical properties as the flux, the spectrum, the emittance and the intensity.

A surface source can be defined with any face in a geometry which emits rays.

1. If it is a blank part, select a plane in the FeatureManager design tree, draw a sketch and extrude it.
   - The origin and the axis of this rectangle will be used for the origin and the orientation of the source.
2. Click Surface Source (Optical Properties).
   - The PropertyManager appears.
3. Type a name in the Source name box.
   - This name appears in the OptisWorks tree.
4. Click the emissive faces in the graphics area.
5. Set the parameters (see page 25).
6. Click OK.
7. If you want to edit or remove the source, right-click it in the OptisWorks tree, and then select Edit or Remove.
   - You can edit, switch off or switch on for the simulations and switch off or switch on for the ray tracing (see page 42) the source in the assembly.
   - You can edit, delete, copy or assign to faces (see page 42) the source in the part.

Parameters of a Surface Source

Flux
In the Flux group box, you can choose the value and the unit of the flux.

The power of the source can be defined in Watt, a radiometric unit, or in Lumen, a photometric unit.

If you want to import a flux value from an intensity file of a library, you can select the From File check box.

You can select the From File check box only if you set Intensity to Library.

Emittance
In the Emittance group box, you can select the type of emittance.

The emittance of a source describes how each point of a surface emits rays.

In OptisWorks, the emittance can be:

- Uniform.
  - You must click Uniform.

- Described by map (basic or spectral).
  - You must click Variable (XMP), and then browse a file in the box which appears.

In the case of a basic map, you must supply a spectrum for the source and this spectrum is the same for each point of the source.

In the case of a spectral map, the spectrum for the source is generated from the color of each pixel of the bitmap.

A basic map or a spectral map can be generated from a simulation result or from a .bmp file import.

Intensity
In the Intensity group box, you can select the intensity diagram.

The intensity diagram of a source describes in which direction is made the emission.

Lambertian
If you click Lambertian, the created source has a lambertian emission.

Lambertian emission ensures that the source has a uniform radiance distribution. The intensity diagram then follows
cosines law in function of the angle of deflection, with the main propagation direction. The propagation direction is normal to the surface.

\[ I = A \times \cos(\theta) \]

\( A \): Intensity in propagation axis  
\( \theta \): deflection angle  

Radiation laws and relative intensity diagram, characteristic of a lambertian source emitting on a half sphere.  

With Total angle field, you can limit the emission cone of your surface source. Output light is set to 0, for deflection angles (q) bigger than half the Total angle.  

By default, the 180 degrees lambertian value is for one complete hemisphere.  
This kind of surface has the same luminance whatever the observation angle is, as illustrated below.

Set-up of the emissive surface source with three radiance sensor LUM1, LUM2 and LUM3 set respectively with an angle of view with the surface normal of 0°, 30° and 60°.

Radiance map, obtained with a lambertian surface source, observed with the set-up described above.  

A lambertian surface source with a total angle set to 0 has parallel rays.  
Cos  
If you click Cos, the source emission follows a cosines law at nth order.
In Total angle field, set the emission cone of your surface source. Output light is set to 0, for deflection angles \( q \) bigger than half of the Total angle.

In N parameter, set the order of the cosines law.

\[ I = A \times \cos^n(\theta) \]

- \( A \): Intensity in propagation axis
- \( \theta \): deflection angle
- \( n \): order of coslaw

On the left, radiation laws of cos function. On the right, relative radiation diagrams, which are characteristic of cosines distribution for second, third, fourth, and fifth order compared to a lambertian distribution.

This kind of surface has a luminance which varies in function of the observation angle. The picture below illustrates, with the same set-up of than the set-up of the lambertian source, the variation of the luminance in function of the observation angle.

Radiance map, obtained with a lambertian surface source, observed with the set-up described in picture above.

**Gaussian**

If you select Gaussian, the intensity distribution of your source follows a gaussian distribution.
On the left, gaussian distribution laws. On the right, relative radiation distribution of gaussian with FWHM set to 20°, 40°, 60° and 80°, compared to a lambertian distribution.

For more details about the FWHM, you can view Parameters of Lab/Gloss Surface Properties.

When the Gaussian is symmetric, FWHM on x and y axes are the same.

If you click Gaussian, you can select Symmetric gaussian or Asymmetric gaussian.

- If you select Symmetric gaussian, you can type or edit the total angle and the FWHM angle values.
- If you select Asymmetric gaussian, you can:
  - Type or edit the total angle value.
  - Type or edit the FWHM angle X the and the FWHM angle Y.
  - Select datum axis to define the X and Y directions.
For asymmetric gaussian type, if both FWHM X and Y angle values are equal, the axis selection is optional.

Intensity distribution obtained with a gaussian surface source for different values of FWHM in x and y directions.

- With Total angle, you can set the dimensions in light emission.

```
FWHM = 15DEG  
FWHM = 45DEG
```

Illustration of Total angle parameter on the intensity distribution for different FWHM values.

To keep a constant intensity on the axis, you have to tune the source power manually.
Library

If you click Library, in the File box, you can browse a library file. You can also edit the file by clicking Edit...

The intensity distribution is set in function of the intensity distribution input file. This input file must be in format:

<table>
<thead>
<tr>
<th>FILE FORMAT</th>
<th>EXTENSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>IESNA</td>
<td>.ies</td>
</tr>
<tr>
<td>Eulumdat</td>
<td>.ldt</td>
</tr>
<tr>
<td>OPTIS intensity files</td>
<td>.int, .int</td>
</tr>
<tr>
<td>Extended Map files</td>
<td>.xmp</td>
</tr>
</tbody>
</table>

You can select only XMP maps with conoscopic intensity. With X direction and Y direction, you set orientation of the source intensity distribution by selecting datum axes. The intensity diagram is displayed accordingly in the 3D view.

You can click Reverse Direction to reverse the intensity diagram.

Exit Geometries

Light source definition permits to take into account elements influencing intensity distribution as for example a bulb in the case of a light bulb or a lens in the case of a LED.

If you selected the Library or the Asymmetric Gaussian intensity types, you can select geometries influencing intensity distribution in the Exit Geometries list.

Those geometries are present during source measurement and could influence its near and far field optical behavior.

Intensity distribution without specific exit geometry

Intensity distribution with lens defined as exit geometry.

Spectrum

You can select the type of spectrum.

You can select a monochromatic source, a blackbody or a .spectrum file from the library.

If you click Monochromatic (nm), the wavelength appears in nanometer. This limitation control works when the flux is defined in lm.

If you click Blackbody(K), the temperature appears in Kelvin.

If you click Library, you must browse a .spectrum file.

Ray Tracing

- In Ray tracing group box, you must select True color or False color.
  
  When selecting False color, you can choose the color by clicking Choose color....

- In Number of rays box, you can type or edit the value.

  The components with a declared temperature are treated as sources whose power depends on the absorption and the volume or on the surface of the geometry, their emittance is uniform and their intensity diagram is Lambertian (surfacic) or isotropic (volumic).
<table>
<thead>
<tr>
<th>EMISSION</th>
<th>Simulations</th>
<th>Direct Simulations</th>
<th>Inverse Simulations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAMBERTIAN</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>ISOTROPIC</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>COSθ</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>GAUSSIAN</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>EULUMDAT</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>OPTIS INTENSITY</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>XMP BASIC</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>XMP SPECTRAL</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>RAY FILES</td>
<td>✔️</td>
<td>✗</td>
<td>✗</td>
</tr>
</tbody>
</table>
Ray File Source

Creating a Ray File Source

A ray file source can only be created in a part file.

With a ray file source, you can use the OPTIS native ray file format to describe the emission of a light source.

A ray file source is a pre-calculated source which emits all the rays in a .ray file. This file contains positions, directions, and wavelengths for each ray.

You can create as many ray file sources as you want.

Sometimes, it is useful, to save the simulation time, to split a simulation in two parts. The first simulation can be dedicated to simulate the light propagation in parts with a definitive design (for instance the filament, the bulb and the socket of a lamp). The second simulation can be dedicated to simulate the light propagation in parts currently in the design process (for instance a reflector).

A ray file source can be created by using a ray file generated by the first simulation. Then, the ray file source can be used to replace the first part of the optical system in the second simulation. At each simulation done to optimize the second part of the optical system, the simulation time dedicated to the ray propagation in the first part is saved.

Generally, with this tip, you can save between 20% and 80% of the simulation time.

1. If it is a blank part, select a plane in the FeatureManager design tree, draw a sketch and extrude it.
   The origin and the axis of this rectangle will be used for the origin and the orientation of the source.

2. Click Ray file Source (Optical Properties).
   The PropertyManager appears.

3. Type a name in the Source name box.
   This name appears in the OptisWorks tree.

4. Set the parameters (see page 32).

5. Click OK.

6. If you want to edit or remove the source, right-click it in the OptisWorks tree, and then select Edit or Remove.
   You can edit, switch off or switch on for the simulations and switch off or switch on for the ray tracing (see page 42) the source in the assembly.
   You can edit, delete, copy or assign to faces (see page 42) the source in the part.

Parameters of a Ray File Source

Axis System
In the Axis System group box, you can click Rectangular surface or 1 point - 2 lines.
If a ray file source is applied to a rectangular face, the edges of the rectangle are used to define the orientation of the ray file source (Ox and Oy axes).

Rectangular Surface
When you click Rectangular surface, the Rectangular surface group box appears.
If you want to select a rectangular surface in the Rectangular surface group box, click a face in the graphics area.

1 point - 2 lines
When you click 1 point - 2 lines, the 1 point - 2 lines group box appears.
You must draw two axes before clicking 1 point - 2 lines to set the axis system.
To select one point in the Origin box, and two lines in the X Direction box and in the Y Direction box, you must click them in the graphics area.

Geometries
With OptisWorks, you can associate geometries to a ray file source.
The rays are propagated without interaction with associated geometries up to other external geometries.
After an interaction with an external geometry, the rays are propagated taking into account the associated
With this functionality, you can, for example, use a ray file to describe the light emission of a lamp and in the same time to model the shadow created by the lamp geometry. Itself can be very critical in many optical systems.

**Photometry**
You must browse a ray file (.ray).
These ray files can be generated during a direct simulation (see page 92) by a ray's map detector, with another compatible software or given by some suppliers.

**Flux**
In the Flux group box, you can choose the value and the unit of the flux.
You can define power of the source in Watt, a radiometric unit, or in Lumen, a photometric unit.
If you want to import the flux value from the ray file, you can select the From File check box.

**Ray Tracing**
In the Ray tracing group box, you must set a value in the Number of rays spinbox to set the number of rays.
You can choose the color of the rays by clicking False color, and then Chooses color...

**Thermic Surface Source**

**Creating a Thermic Surface Source**
A thermic surface source can only be created in a part file.
A thermic surface can define the source for which the total flux and the spectrum are defined by the temperature of the source and the optical properties of the support geometry.

A thermic surface source can be defined on any face of the geometry.

1. If it is a blank part, select a plane in the FeatureManager design tree, draw a sketch and extrude it.

2. Click Thermic Surface Source (Optical Properties).
   
   The PropertyManager appears.

3. Type a name in the Source name box.
   
   This name appears in the OptisWorks tree.

4. Click the emissive faces in the graphics area.

5. Set the parameters (see page 35).

6. Click OK .

7. If you want to edit or remove the source, right-click it in the OptisWorks tree, and then select Edit or Remove.

   You can edit, switch off or switch on for the simulations and switch off or switch on for the ray tracing (see page 42) the source in the assembly.

   You can edit, delete, copy or assign to faces (see page 42) the source in the part.
Parameters of a Thermic Surface Source

Parameters
In the Parameters group box, you must set the temperature value in the spinbox.
The thermic surface source power is calculated as a function of:
• the surface quality (Kirchhoff law).
• the blackbody temperature (Stefan-Boltzmann law).
• the emissive surface area.

Intensity
In the Intensity group box, you must select the type of intensity distribution.
The intensity diagram of a source describes in which directions is made the emission.
You can select the Reverse direction check box to reverse the direction.

Lambertian
The simplest model is Lambertian which is a distribution law given by \( \cos(\theta) \).
The intensity diagram can be limited to a cone by giving the half angle.
The angle limitation is only available as an option.
The default value 90° is for one complete hemisphere.
The intensity formula for Lambertian is \( I = \cos(\theta) \).
Cos: \( I = \cos(n \theta) \).
The following image shows a luminance map of a source with the lambertian law for an intensity distribution.

Cos
If you click Cos, you must set a value in spinbox.
You can select the Reverse direction check box to reverse the direction.
The following image shows a luminance map of a source with the \( \cos n \theta \) law for an intensity distribution.
Ray Tracing
In the Ray tracing group box, you must set a value in the Number of rays spinbox to set the number of rays. You can choose the color of the rays by clicking False color, and then Chooses color...
Interactive Source

Creating an Interactive Source

An interactive source can only be created in an assembly file.

An interactive source generates specific light rays which are useful to understand the behavior of a light beam through an optical system. Its purpose is not to model the real emission of the light source as a LED or a filament. The interactive sources are generally created to be used in a ray tracing (see page 84). They can be used simultaneously in the ray tracing.

1. Click Interactive Source (Ray Tracing).

   The PropertyManager appears.

2. Select the source type you want from the Source Type list.

3. Type a name in the Source name box.

4. Set the parameters (see page 37).

5. Click OK.

   The interactive source appears in the OptisWorks tree.

   You can edit, delete, suppress or unsuppress (see page 37) the source.

Parameters of an Interactive Source

To create an interactive source you must have two geometries, one for the propagation's start and one for the propagation's end.

For example, if you select Point-Direction from the Source Type list, it means that the beginning geometry is a point and the end geometry a direction. The interactive source makes the link between both geometries in a points to points way. Then the propagation of the source is done through the system.

Start

You must select the start of the geometry by clicking it in the graphics area or in the FeatureManager design tree.

   Sampling

   You must set up the sampling that you want for your geometry.

End

You must select the end of the geometry by clicking it in the graphics area or in the FeatureManager design tree.

   Sampling

   You must set up the sampling that you want for your geometry.

   Wavelength

   You must set the wavelength in the spinbox.

Managing the Interactive Source within the OptisWorks Tree

The source appears in the OptisWorks tree.

1. Double-click Sources, Interactive Sources.

2. If you want to edit the source, right-click it, and then select Edit.

3. If you want to delete the source, right-click it, and then select Delete.

4. If you want to suppress or unsuppress the source, right-click it, and then select Suppress or Unsuppress.

OLED Source

Creating an OLED Source

OLED sources are compatible with direct and inverse simulation.

1. Click OLED Source (Optical Properties).
2. Type a name in the Source name box. This name appears in the OptisWorks tree.

3. Set the parameters (see page 38).

4. Click OK.

5. If you want to edit or remove the source, right-click it in the OptisWorks tree, and then select Edit or Remove.
   - You can edit, switch off or switch on for the simulations and switch off or switch on for the ray tracing (see page 42) the source in the assembly.
   - You can edit, delete, copy or assign to faces (see page 42) the source in the part.

### Parameters of an OLED Source

#### Luminance Field

In the Emissive face box, you must select a face in the graphics area.

You must select Uniform luminance or Luminance field.

- **Uniform luminance** defines a homogeneous emission of light from the surface.
  - You need then to define the Power (lm) of the source.
- **In the Luminance field**, you can browse a .OPTLuminanceField file.
  - Power is automatically computed with the respect of the luminance field, the spectrum and the intensity parameters.

.OPTLuminanceField file format includes description line, number of summits (Ns), number of triangles (Nt), coordinates x,y,z of summits (x Ns), coordinates l,m,n of normals (x Ns), index of summits of each triangle (x Nt), luminance of each summit (x Ns).

#### Axis System Definition

The Axis system definition group box is only available when selecting the Luminance field type. You must click one point and two lines in the graphics area.

You can click Reverse direction to reverse the directions.

#### Spectrum

In the Spectrum group box, you must select Constant or Variable with normal angle.

- **When selecting Constant**, you can browse a .spectrum or .spe file.
  - If needed, you can click . For more details, you can view Spectrum Editor
- **When selecting Variable with normal angle**, you can browse a spectral intensity file or a SETFOS import.
  - The .setfos file must be a 3D SETFOS file, with a spectral intensity.
  - The .spid file has a text format.
    - Line 1 is a header.
      - OPTIS - spectral intensity file v1.0
    - Line 2 is a comment.
    - Line 3 is the number of sampling in theta.
    - Line 4 is the theta list.
    - Line 5 is the number of sampling in phi.
    - Line 6 is the phi list.
    - Line 7 is the number of wavelength.
    - Line 8 is the lambda list.
    - Next lines are the spectrum.
      - SpectralIntensity(theta0, phi0)
      - SpectralIntensity(theta1, phi0)
SpectralIntensity(\(\theta_N, \phi_0\))
SpectralIntensity(\(\theta_0, \phi_1\))
SpectralIntensity(\(\theta_1, \phi_1\))
...
SpectralIntensity(\(\theta_N, \phi_1\))
...
SpectralIntensity(\(\theta_0, \phi_M\))
SpectralIntensity(\(\theta_1, \phi_M\))
...
SpectralIntensity(\(\theta_N, \phi_M\))

\(\text{SpectralIntensity(\(\theta_i, \phi_j\))}\) is the \(N\lambda\) values of intensity on a line.

To have a revolution symmetry, the number of \(\phi\) must be equal to 1 and \(\phi\) value must be 0.

**Intensity**

The Intensity group box is only available when selecting Constant spectrum.
In this group box, you can select the intensity diagram.
The intensity diagram of a source describes in which directions the emission is made.

**Lambertian**
The simplest model is Lambertian which is a distribution law given by \(\cos(\theta)\).
The intensity diagram can be limited to a cone by giving the half angle.
The angle limitation is only available as an option.
The default value 90° is for one complete hemisphere.
The intensity formula for Lambertian is \(I = \cos(\theta)\)
Cos: \(I = \cos(\theta)\).

The following image shows a luminance map of a source with the lambertian law for an intensity distribution.

A lambertian surface source with half angle equal to zero has parallel rays.
Cos
If you click Cos, you must set a value in the n spinbox.
You can select the Reverse direction check box to reverse the direction.
The following image shows a luminance map of a source with the Cosθ law for an intensity distribution.

Library
The distribution can also be given by an intensity distribution file in an IES, an Eulumdat or an OPTIS intensity format. These are Libraries.

You can also browse a 2D SETFOS file if you selected Constant in the Spectrum group box.
If you click Library, the Intensity axis box appears in case the distribution does not include revolution symmetry.
You can select the X and Y directions to set up the axis system.
The axes can be global or local:
- Global axis is the orientation of the intensity diagram is related to the axis system.
- Local axis is the orientation of the intensity diagram is related to the normal at the surface.

Ray Tracing
In Ray tracing group box, you must select True color or False color.
When selecting False color, you can choose the color by clicking Chooses color….
In Number of rays box, you can type or edit the value.

The components with a declared temperature are treated as sources whose power depends on the absorption and the volume or on the surface of the geometry, their emittance is uniform and their intensity diagram is Lambertian (surfacic) or isotropic (volumic).

Preview Luminance Field
You must select the Luminance field type to access the Update button.
You can click Update to preview the luminance field.

Source Group
Creating a Source Group
With the Source Group, you can gather several sources in the same group.
Source groups can only be used in a direct or inverse simulations and must be in the same assembly than the simulation.
You can add all source types excepted interactive, ambient, laser and optical sources.
All sources of a same group are stored in the same layer of a result file.

1. Click Source Group (Additional Features).
2. Set the parameters (see page 41).
3. Click OK ✓.
The Source group appears in the OptisWorks tree.

- If you add a source which already belongs to another Source group or a source with an error status, the Source group appears with an error status.
- If you want to add another source to the Source group, you can drag a source directly to a Source Group in the OptisWorks tree.
- If you want to edit a Source group, right-click it in the OptisWorks tree and select Edit.
- If you want to suppress or unsuppress a Source group, right-click it in the OptisWorks tree and select Suppress or Unsuspend.
- If you want to delete a Source group, right-click it in the OptisWorks tree and select Delete
- Or-
- If you want to delete a Source group, select it in the OptisWorks tree and press Suppr.

Parameters of a Source Group

1. Type a name in the Source group name box.
2. In Source group definition, select the sources you want to add to the Source group in the Source list

   - You can click Select All if you want to add all the sources to the Source group.

   - You must select at least two sources before validating the Source group.
Sources Management

Managing the Sources within the OptisWorks Tree

All the sources created appear in the OptisWorks tree.

You can manage like follows surface sources, ray file sources, thermic surface sources and OLED sources.

1. Double-click Sources.
2. If you want to edit the source, right-click it, and then select Edit.
3. If you want to switch on or off the source for the simulation or for the ray tracing, right-click the source, and then select Switch off for the simulations or Switch off for the ray tracing or Switch on for the simulations or Switch on for the ray tracing.

If you want to switch on or off a source in a case of a multi-configuration, you can choose if you want to apply this action to the current configuration, to all the configurations or to a selected list of configurations.

The name of the part in which the source is defined appears.

You can double-click the part to open it.

Managing the Sources

The Source management box is used to manage the sources defined in your part.

1. Click Source Management (Optical Properties).
   In the PropertyManager, select the source you want to manage.
2. Click Edit, Delete, Copy or Assigns to face(s) according to what you want to do.
   By clicking Edit, the Source definition box opens and you can change the parameters of the source.
   By clicking Delete, you can delete the source.
   Clicking Copy opens a new source with the same initial definition that the one selected.
   By clicking Assign to face(s), you can modify faces.

When several sources are defined, you can select a source in the list and replace it with another source.
Select a source in the Source list, then select an active source in the Replace with list and click Replace.

Note: When the two sources are assigned to different emissive faces, the replacing source inherits the face selection from the source you replaced.
Detectors Overview

Creating a detector can only be done in an assembly.

You can use as many detectors as you like.

- **Illuminance detector (see page 45)**
  This detector is used to compute the illuminance (Lux) or the irradiance (Watt/m²).
  It is a 2D rectangular area.
  The results are stored in an XMP file.

- **Luminance detector (see page 53)**
  This detector is used to compute the luminance (cd/m²) or the radiance (Watt/m²/sr).
  It is a 2D rectangular area.
  The results are stored in an XMP file.

- **Intensity detector (see page 56)**
  This detector is used to compute the luminous intensity (cd) or the radiant intensity (Watt/sr).
  It is a 2D rectangular area.
  The results are stored in an XMP file.

- **Polar intensity detector (see page 59)**
  This detector is used to compute the luminous intensity (cd) or radiant intensity (Watt/sr).
  The results are stored in an IES, an Eulumdat or an OPTIS intensity file.

- **3D detector (see page 62)**
  With OptisWorks, you can analyze the light on any surface of your system with a 3D detector.
  In some cases, you may be interested by the light in a particular area of the space and not necessary on a surface of the geometry.
  Here, you must use a virtual detector.
  This is a virtual sensor which records the energy when the light rays come through it.
  It is used to measure the quantity of light at the output of your system.
  This detector does not interact with the light.

- **Rays map detector (see page 62)**
  This detector is used to intercept rays.
  It is a 2D rectangular area.
  The results are stored in an OPTIS ray file.

- **3D energy density detector (see page 63)**
  All the detectors that you create appear in the OptisWorks tree.
  By right-clicking them, you can edit, delete, suppress or unsuppress the detector.
  You can use all the possibilities of the software to set the position, the orientation and the size of the detector.
  You can check that your map is correctly oriented and that there is a light going onto it when you display the ray tracing (see page 84).
  All geometry is a detector.
  If you want to analyze the irradiance on the geometry, you must generate a 3D map when you run the direct simulation.
  The 3D map viewer shows the irradiance directly on the geometry.
  If you do not find the OptisWorks Detectors toolbar, you must click the View menu, Toolbars, OptisWorks Detectors.
Illuminance Detector

Creating an Illuminance Detector

This detector is used to compute the illuminance (Lux) or the irradiance (Watt/m²). The results are stored in an XMP file.
You can use the Virtual Photometric Lab to display this file.

1. Click Illuminance Detector (Detectors).
   - The PropertyManager appears.
2. Set the parameters (see page 45).
3. Click OK.
   - You can edit, delete, suppress or unsuppress (see page 65) the detector.
   - You can show or hide the result in the 3D view (see page 65).
   - You can copy a detector (see page 65) in the same assembly or in another one.

Parameters of an Illuminance Detector

Geometry
In the Geometry group box, you must click Rectangular surface or 1 point - 2 lines.
If you click 1 point - 2 lines, a Detector name box and a Map Size group box appears.
You must type a name in the Detector name box.
In the Map Size group box, to dimension the map, set the value of the X min, X max, Y Min and Y Max boxes.
If you click Rectangular surface, the name of the detector is the name of the part.
The Virtual Photometric Lab can only display a rectangular map.
Here, the rectangular surface used to define the detector must be in a separated part.

Selected Component
To select the component, you must click it in the graphics area.
Depending on the selection for the geometry, the component to select is a rectangular surface or three points which are used to define an axis system.

Type of Detector
In the Type of detector box, you must select a detector type.
- Click Photometric detector to compute the luminous intensity (lux) and generate a BASIC map for the Virtual Photometric Lab. All the wavelengths are integrated.
  - The illuminance levels are displayed with a false color and you cannot make a spectral or a colorimetric analysis with this type of map
- Click Radiometric detector to compute the radiant intensity (Watt/m²) and generate a BASIC map for the Virtual Photometric Lab. All the wavelengths are integrated
  - The illuminance levels are displayed with a false color and you cannot make a spectral or a colorimetric analysis with this type of map
- Click Spectral detector to get results both in Lux and Watt/m² and generate a spectral map for the Virtual Photometric Lab.
  - You can make a spectral or a colorimetric analysis on each pixel of your map.
  - As the spectral map contains more information, it takes more time to open it in the Virtual Photometric Lab.

Sampling
In the Sampling box, set the X and Y values.
The sampling is used to define the number of pixels of the XMP map.
X resolution and Y resolution correspond to the automatic calculation of the size of one pixel along X and Y directions.
Axis
With the axis system parameters, you can define the orientation of the detector.
When you select the detector in the OptisWorks tree, the Z axis is displayed in the 3D view.
The Z axis is a normal axis to the detector's surface which defines the sensitive face of the detector.
Photons are integrated when they arrive there.

There also are different types of integration to measure illuminance. Illuminance is the physical quantity defined by
the luminous flux received on sensor area.
Depending on the simulation you need, you can use different integration types.
The most frequent type is the planar type. In this type, the illuminance on a point is calculated by the cosine on the
angle of incidence $\varepsilon$. The formula is:

$$E = \frac{I \cdot \cos \varepsilon}{D^2}$$

Planar mode with an integration direction normal to the sensor plan

For the other types, calculation is based on standard EN-13201
(http://www.e-streetlight.com/standard_en13201.htm), which gives mathematical formulas equivalent to
different types of illuminance.

Compared to the EN-13201 standard, several parameters are simplified.

- To select one point in the Center of the Map box, and two lines in the Direction of the X axis box and in the
  Direction of the X axis box, you must click them in the graphics area.
  You can click Reverse direction to reverse the direction.
- You must select an Integration type.
  This direction can be selected from the geometry.
  - You can select Planar (see page 47).
    In this case, you can define an integration direction.
  - You can select Radial (see page 49).
    In this case, you do not have to define any integration direction.
  - You can select Hemispherical (see page 49).
    In this case, defining an integration direction is mandatory.
  - You can select Cylindrical (see page 50).
    In this case, no integration direction is required.
  - You can select Semi-Cylindrical (see page 50).
    In this case, you must select a direction parallel to the sensor plan.
  Default type is Planar.
- Click a direction in the graphics area to select it in the Integration direction box if necessary.
  You can click Invert direction to reverse the direction.
Parameters

Data Separated by Layer
When you clear the Data separated by layer check box, the simulation generates a BASIC XMP map (or a SPECTRAL map if the Colorimetric type is selected).

- You can click By source to get a the result including one layer per active source. You can then change Sources' power or spectrum by using Virtual Lighting Controller present in Virtual Photometric Lab and Virtual Human Vision Lab.
- When you click By surface (SCA), the result includes one layer per surface selected using the surface contribution analyzer (see page 107) option.
- When you click By sequence, the result includes one layer per sequence selected using the stray light analysis (see page 114) option.
- When you click By Polarization, the result includes one layer per Stokes parameter using the polarization option.

Stokes parameters are displayed using the layers of the Virtual Photometric Lab. For more information, you can view Stokes Parameters. This parameter is only available if you selected the Radiometric type.

Generate LPF File
The Generate LPF file option is used for the light path finder (see page 104) analysis. You can select the check box, and set the value of the Max paths box.

Associate a Measure Template to XMP
You can select a template .xml file containing default measure data exported from an existing .xmp. Measures are then automatically created in the .xmp generated during the simulation according to the measure data defined in the template file.

Select the Associates a measure template to XMP check box and browse a .xml file containing measure data. The generated .xmp is not related to the measure template file. If you modify the template file, the generated .xmp remains the same.

Precision (%)
The Precision parameter is available only if you selected the Colorimetric Detector type.
The Precision (%) parameter is only used for Monte Carlo inverse simulations. You can use the Precision (%) parameter to define how many rays are propagated in each pixel when running an illuminance simulation (number of rays = 1 / precision2, for example 100 rays for 10%). Set the value of the Precision box.

Output faces
The Output faces parameter is available only if you selected the Colorimetric Detector type.
The Output faces parameter is only used for Monte Carlo inverse simulations. You can set the faces the rays are going to aim from the sensor during inverse simulations in the Output Faces selection list. This helps improving performances.

Spectral Data
The Spectral Data group box appears if you select Spectral Detector.
In the Spectral data group box, you can modify the wavelength sampling. Set the value of the Lambda min, Lambda max and Sampling boxes.

Planar Illuminance
On the following example, the source is simulated by a local point source. The source can also be an extended light source like luminaire, ambient, surface source, etc.
Note that in this integration type, the pixel is only sensitive on one side. Its sensitivity is lambertian.
Three types of integration direction can be simulated for Planar illuminance.

**Horizontal plan**
The horizontal illuminance is the most common way to calculate illuminance. The integration direction is perpendicular to the horizontal plan and the surface sensor. The normal illuminance follows the Bouguer law.

\[ E_{\text{Horizontal}} = \frac{I \cdot \cos \varepsilon}{D^2} \]

**Illuminance on horizontal sensor**

**Vertical plan**
When the surface sensor is applied vertically, the lateral orientation becomes a significant parameter to determine the illuminance. The integration direction is perpendicular to the vertical plan and parallel to the surface sensor. An example of this can be a wall on the road.

\[ E_{\text{Vertical}} = \frac{I \cdot \cos \alpha \cdot \sin \varepsilon}{D^2} \]

**Illuminance on vertical sensor with lateral deviation (angle \( \alpha \))**
In the specific case where \( \alpha \) is equal to 0 (like the object on the right of the above figure), the illuminance calculation is the same as for the horizontal type. It does not depend on the \( \alpha \) factor. The mechanical plan only is different, so the two coordinates systems have different orientations.

\[ E_{\text{Vertical Specific}} = \frac{I \cdot \sin \varepsilon}{D^2} \]
General case
In the general case you must define the integration direction. The same integration direction is applied on each pixel of the sensor. On the figure below, this direction is perpendicular to blue mechanical plans.

Planar illuminance in general case

Radial Illuminance
On the following example, the source is simulated by a local point source. The source can also be an extended light source like luminaire, ambient, surface source, etc.
Note that in this integration type, the sensitivity of the pixel does not depend on where the rays are coming from. The integration direction is the incident flux. This direction is on the vertical plan at right-angle to the surface. Then, the angle of incident ε is equal to 0° and cos ε = 1. The illuminance formula is:

\[ E_{\text{Radial}} = \frac{I_x}{D^2} \]

Hemispherical Illuminance
On the following example, the source is simulated by a local point source. The source can also be an extended light source like luminaire, ambient, surface source, etc.
Note that in this integration type, the sensor is sensible to light incoming from all directions except the direction exactly opposed to the integration direction.
The hemispherical illuminance is an addition of horizontal and radial illuminance. The integration direction is perpendicular to the sensor plane. The integration direction is the same like horizontal illuminance (perpendicular to the horizontal plan).
Cylindrical Illuminance

On the following example, the source is simulated by a local point source. The source can also be an extended light source like luminaire, ambient, surface source, etc.

Note that in this integration type, the sensor is sensible to light incoming from all directions except the direction exactly normal to the sensor plane.

The cylindrical illuminance can be defined by the specific case of vertical illuminance (when $\alpha = 0^\circ$). Because of the rotational symmetry (around z axis) only the angle $\varepsilon$ is important, we do not need a specific integration direction.

$$E_{\text{Hemispherical}} = \frac{I_c(1 + \cos \varepsilon)}{4D^2}$$

Semi-Cylindrical Illuminance

On the following example, the source is simulated by a local point source. The source can also be an extended light source like luminaire, ambient, surface source, etc.

Note that in this integration type, the sensor is sensible to light incoming from all directions, except the directions included in a half plan delimited by the cylinder axis and situated behind the half cylinder.

Contrary to the cylindrical illuminance, we need an integration direction to calculate the semi-cylindrical illuminance. In addition, the illuminance depends on the lateral deviation (like the vertical illuminance).
\[ E_{\text{Hemicylindrical}} = \frac{I_2 \sin \varepsilon (1 + \cos \alpha)}{\pi D^2} \]
Ray Map Detector

Creating a Ray Map Detector

This detector is used to intercept rays. The results are stored in an OPTIS ray file. You can use the ray file editor to edit this file.

1. Click Ray Map Detector (Detectors).
   The PropertyManager appears.
2. Set the parameters (see page 52).
3. Click OK.

   You can edit, delete, suppress or unsuppress (see page 65) the detector.
   You can show or hide the result in the 3D view (see page 65).
   You can copy a detector (see page 65) in the same assembly or in another one.

Parameters of a Rays Map Detector

Geometry
In the Geometry group box, you must click Rectangular surface or 1 point - 2 lines. Depending on the selection for the geometry, the component to select is a rectangular surface or three points which are used to define an axis system.

If you click Rectangular surface, the name of the detector is the name of the part.
Here, the rectangular surface used to define the detector must be in a separated part

Selected Component
The Selected Component group box appears when clicking Rectangular surface.
You must click a rectangular surface in the graphics area.

Detector Name
The Detector name group box appears when clicking 1 point-2 lines.
You must type a name in the box.

Detector Definition
The Detector definition group box appears when clicking 1 point - 2 lines.
To define the detector, you must click three points in the graphics area.

Map Size
The Map Size group box appears when clicking 1 point - 2 lines.
You must set a value in the X min, X max, Y Min and Y Max spinboxes.

Axis
In the Axis group box, you must select one or more check boxes.
It is used to define the sensitive face of the detector.
When you select the detector in the OptisWorks tree, its Z axis is displayed in the 3D view.
Luminance Detector

There is a best place for position in a luminance simulation with XMP map post-processing. The luminance sensor is represented as a pyramid in the 3D view. The peak of the pyramid may represent the position of the eye (point at) and the center of the map is given by the Position coordinates. It means that you are observing a scene from the peak and through the map. So, it is better to put the center of the map in front of the light source.

Creating a Luminance Detector

This detector is used to compute the luminance (cd/m²) or the radiance (Watt/m²/sr). The results are stored in a XMP file. You can use the Virtual Photometric Lab to display this file. The luminance detector is displayed as a pyramid, the rectangular base is the map and the top is the observer.

1. Click Luminance Detector (Detectors).
   The PropertyManager appears.
2. Type a name in the Detector name box.
3. Set the parameters (see page 53).
4. Click OK.
   - You can edit, delete, suppress or unsuppress (see page 65) the detector.
   - You can show or hide the result in the 3D view (see page 65).
   - You can copy a detector (see page 65) in the same assembly or in another one.

Parameters of a Luminance Detector

Geometry
In the Geometry group box, you must click Current view point or 1 point - 2 lines. When you define a luminance detector for the first time, most of the parameters are initialized from the current view point.

View Point
The View point group box appears when clicking Current view point. The observer is given by the view point. You can modify the view point by setting a value in the X, Y and Z boxes.

Detector Definition
The Detector definition group box appears when clicking 1 point - 2 lines. To define the detector, you must click three points in the graphics area.

Orientation
The Orientation group box appears when clicking Current view point. The orientation is the axis starting from the observer and passing through the center of the map.
You can modify the orientation by setting a value in the Theta, Phi and Psi boxes.

![Diagram of orientation angles]

**Luminance Plane**
The luminance plane parameters are used to define the position and the size of the map. You can modify it by setting a value in the Distance, Width and Height boxes.

**Type of Detector**
In the Type of detector box, you must select a detector type.
- Click Colorimetric detector to get colorimetric results both in Lux and Watt/m2.
- Click Spectral detector to get colorimetric and spectral results both in Lux and Watt/m2 and generate a spectral map for the Virtual Photometric Lab.
  
  As the spectral map contains more information, it takes more time to open it in the Virtual Photometric Lab.

**Parameters**
The Precision (%) parameter is used to define how many rays are propagated in each pixel when running a luminance simulation (number of rays = 1 / precision^2, for example 100 rays for 10%). You can modify it by setting a value in the Precision box.

- **Precision (%)** is only used for an inverse simulation (see page 95).

  You can modify the direct integration angle by setting a value in the Direct integration angle box. You can view Integration Angle Parameters.

- The direct integration angle is only used for a direct simulation (see page 92).

**Data Separated by Layer**
By clearing the Data separated by layer check box, the simulation generates a BASIC XMP map (or a spectral map if the Colorimetric type is selected).

By clicking By source, the result includes one layer per active source. Sources’ power or spectrum can then be changed by using Virtual Lighting Controller present in Virtual Photometric Lab and Virtual Human Vision Lab.

By clicking By surface (SCA), the result includes one layer per surface selected using the surface contribution analyzer (see page 107) option.

By clicking By sequence, the result includes one layer per sequence selected using the stray light analysis (see page 114) option.

**Generate LPF file**
The Generate LPF file option is used for the light path finder (see page 104) analysis.

Select the check box and set a value in the Max paths box.
**Associate a Measure Template to XMP**

You can select a template .xml file containing default measure data exported from an existing .xmp. Measures are then automatically created in the .xmp generated during the simulation according to the measure data defined in the template file.

Select the Associates a measure template to XMP check box and browse a .xml file containing measure data.

The generated .xmp is not related to the measure template file. If you modify the template file, the generated .xmp remains the same.

**Spectral Data**

In the Spectral data group box, you can modify the wavelength sampling. Set a value in the Lambda min, Lambda max and Sampling boxes.

**Sampling**

In the Sampling box, in the X and Y boxes, you must type a value or use the arrows to change it. The sampling is used to define the number of pixels of the XMP map.

X resolution and Y resolution correspond to the automatic calculation of the size of one pixel along X and Y directions.

**Axis**

In the Axis group box, you must select one or more check boxes. This modifies the orientation of the detector.
**Intensity Detector**

**Creating an Intensity Detector**

This detector is used to compute the luminous intensity (cd) or the radiant intensity (Watt/sr). The results are stored in an XMP file.

You can use the Virtual Photometric Lab to display this file.

This detector is placed at the infinite.

The direction of this detector is given by the Detector definition parameters.

The size of the detector does not change anything.

1. Click **Intensity Detector** (Detectors).
   The PropertyManager appears.
2. Type a name in the **Detector name** box.
3. Set the parameters (see page 56).
4. Click **OK**.

You can edit, delete, suppress or unsuppress (see page 65) the detector.

You can show or hide the result in the 3D view (see page 65).

You can copy a detector (see page 65) in the same assembly or in another one.

**Parameters of an Intensity Detector**

**Detector Definition**

The detector definition parameters are used to define the orientation of the detector.

To define the detector, you must click three points in the graphics area.

The vector \( Z \) is built by the product of \( X \) and \( Y \).

The \( Z \) vector gives the axis of the detector.

**Type of Detector**

In the Type of detector box, you must select a detector type.

- Click **Photometric detector** to compute the luminous intensity (cd) and generate a basic map for the Virtual Photometric Lab. All the wavelengths are integrated.
  The illuminance levels are displayed with a false color and you cannot make a spectral or a colorimetric analysis with this type of map
- Click **Radiometric detector** to compute the radiant intensity (Watt/sr) and generate a basic map for the Virtual Photometric Lab. All the wavelengths are integrated.
  The illuminance levels are displayed with a false color and you cannot make a spectral or a colorimetric analysis with this type of map
- Click **Spectral detector** to get results both in Lux and Watt/m2 and generate a spectral map for the Virtual Photometric Lab.
  You can make a spectral or a colorimetric analysis on each pixel of your map.

As the spectral map contains more information, it takes more time to open it in the Virtual Photometric Lab.

**Type of Intensity Detector**

In the Type of intensity detector group box, you must click SAE-A type, SAE B type, Optis intensity or Conoscopic.

**SAE A and SAE B**

In the Map Size group box, you must set a value in the \( X \) min, \( X \) max, \( Y \) Min and \( Y \) Max boxes.

The \( X \) vector gives the direction 0° of the map.

The \( Y \) vector gives the horizontal direction of the map.

The \( Z \) vector gives the vertical direction of the map.

The parameters of the map size are used to define the maximum and the minimum angles of the detector.
SAE maps are often used for automotive regulations.

**OPTIS Intensity**

In the Map Size group box, you must set a value in the X min, X max, Y Min and Y Max boxes.

The X vector gives the horizontal direction of the map.
The Y vector gives the vertical direction of the map.
The Z vector gives the direction theta = 0°.

The parameters of the map size are used to define the maximum and the minimum angles of the detector.

For OPTIS Intensity maps the relation between ThetaX, ThetaY (used in the Virtual Photometric Lab) and the standard angle Theta and Phi is:

- \( \text{ThetaX} = \text{Theta} \times \cos(\Phi) \)
- \( \text{ThetaY} = \text{Theta} \times \sin(\Phi) \)

**Conoscopic**

In the Map Size group box, you must set a value in the Theta Max box.

The parameters of the map size are used to define the maximum and the minimum angles of the detector.
The map Size with Theta Max must be defined.

**Near Field**

This feature is useful only to compare simulated intensity to measured intensity on small size devices. You cannot use the result of a near field detector to model the near field of a light source for instance.

The result of a simulation using a near field detector is closer to physical experiments.

- If you do not select the Near field box, the intensity is located at the infinite.
- If you select the Near field box, you must set a value in the Cell distance and Cell diameter boxes to match the measurement tool.

  The size of the cell must be superior to one pixel.
  Sensor visualization in the 3D view is set according to the cell distance value.
  The results obtained with a near field detector can be inaccurate on the edge of the map, over a width equal to the radius of a cell.

**Map Size**

The Map size group box depends on the type of intensity detector.

**Sampling**

In the Sampling box, set the value of the X and Y boxes.
The sampling is used to define the number of pixels of the XMP map.

X resolution and Y resolution correspond to the automatic calculation of the size of one pixel along X and Y directions.

**Axis**

In the Axis group box, you must select one or more check boxes.
It is used to modify the orientation of the detector.

**Parameters**

**Data Separated by Layer**

By clearing the Data separated by layer check box, the simulation generates a basic XMP map map (or a spectral map if Colorimetric is selected).

By clicking By source, the result includes one layer per active source.
Sources’ power or spectrum can then be changed by using the Virtual Lighting Controller present in Virtual Photometric Lab and Virtual Human Vision Lab.

By clicking By surface (SCA), the result includes one layer per surface selected using the surface contribution analyzer (see page 107) option.
By clicking By sequence, the result includes one layer per sequence selected using the stray light analysis (see page 114) option.

**Flip XMP Horizontally**

In Flip XMP horizontally box, you must select true or false.

This horizontal flip parameter avoids end-users to manually flip the result at the end of each update.

---

**Generate LPF File**

The Generate LPF file option is used for the light Path Finder (see page 104) analysis.

You can select the check box, and then set a value in the Max paths box.

**Associate a Measure Template to XMP**

You can select a template .xml file containing default measure data exported from an existing .xmp.

Measures are then automatically created in the .xmp generated during the simulation according to the measure data defined in the template file.

Select the Associates a measure template to XMP check box and browse a .xml file containing measure data.

The generated .xmp is not related to the measure template file. If you modify the template file, the generated .xmp remains the same.

**Spectral Data**

The Spectral Data group box appears if you select Spectral Detector.

In the Spectral data group box, you can modify the wavelength sampling.

You can set the value of the Lambda min, Lambda max and Sampling boxes.

**Visualization Parameters**

You can select the Visualization radius check box.

Type or edit the value to change the radius of the sensor and intensity map displayed in the 3D view.

If you select Near field, the value of the near field radius is taken into account instead of the value set in Visualization radius.
Polar Intensity Detector

Creating a Polar Intensity Detector

This detector is used to compute the luminous intensity (cd) or the radiant intensity (Watt/sr). The results are stored in an IES, an Eulumdat or an OPTIS intensity file. There is a specific viewer for each of these files.

This detector is placed at the infinite. The direction of this detector is given by the detector definition parameters.

1. Click Polar Intensity Detector (Detectors).
   The PropertyManager appears.
2. Type a name in the Detector name box.
3. Set the parameters (see page 59).
4. Click OK.

You can edit, delete, suppress or unsuppress (see page 65) the detector.
You can copy a detector (see page 65) in the same assembly or in another one.

Parameters of a Polar Intensity Detector

Detector Definition

The detector definition parameters are used to define the orientation of the detector.

To define the detector, you must click three points in the graphics area.
The vector Z is built by the product of X and Y.
The Z vector gives the axe of the detector.

Type of Polar Intensity Detector

In the Type of polar intensity detector group box, you must click IES A, IES B, IES C, EuLumdat, Optis intensity radiometric or Optis intensity photometric.

IES

US standard data format for storing the spatial light output distribution for luminaries.
It is a not so well structured text file format, which stores luminous intensity values in Candelas.
There are three different specifications to this format.
The IES format gives the light output of the installed lamps only per lamp, which makes the definition of luminaries with different types of lamps installed next to each other very clumsy.
The current specification has more strict requirements for storing meta information like manufacturer, luminary name, catalog number etc. than the early ones, but those specifications are still not always respected by the manufacturers.
The format provides the theoretical possibility to specify variations of a luminary, but this possibility is not defined well enough to be of practical value.

Eulumdat

European standard data format for storing the spatial light output distribution for luminaries.
It is a well structured text file format, which stores luminous intensity values in Candela per total kilo Lumens installed in the luminary.
This allows for luminaries with several types of lamps installed next to each other, which is not possible with other Format like for example IES Format. Eulumdat also offers a practical solution to luminaries that are available with different lamps to choose from.

Near Field

This feature is useful only to compare simulated intensity to measured intensity on small size devices. You cannot use the result of a near field detector to model the near field of a light source for instance.
The result of a simulation using a near field detector is closer to physical experiments.
• If you do not select the Near field box, the intensity is located at the infinite.
• If you select the Near field box, you must set the values of the Cell distance and Cell diameter boxes to match the measurement tool.

  The size of the cell must be superior to one pixel.
  Sensor visualization in the 3D view is set according to the cell distance value.
  The results obtained with a near field detector can be inaccurate on the edge of the map, over a width equal the radius of a cell.

**Sampling**
The sampling is used to define the angles of the result.
You can choose between a uniform sampling given the number of angles in the C-plane = xOy and the number of G-angles = Oz axis or an adaptive sampling.

For an adaptive sampling, the values and the angles are read from a .txt file.
You can find examples.
The path of those examples is C:\Program Files\OPTIS\Standards\Photometry\Intensity Distribution.

If you click Uniform sampling, you must set the parameters in the Uniform sampling group box.
If you click Adaptive sampling (file), you must set the parameters in the Parameters group box.

**X resolution**, **Y resolution** and **Z resolution** correspond to the automatic calculation of the size of one pixel along X, Y and Z directions.

**Uniform Sampling**
You must set a value in the different boxes.

The uniform sampling depends on the type of polar intensity detector.
For an IES type (A, B and C), you must set the H Angle sampling and V Angle sampling.
For a Eulumdat and an Optis intensity type, you must set the C-Plane sampling (Number of sample in the C-Plane (xOy)) and the Gamma angle.

You can select the Automatic calculation check box to compute automatically the integration angle according to the sensor sampling.

**Adaptive Sampling**
A .txt file must be selected.
You can find examples.
The path of those examples is C:\Program Files\OPTIS\Standards\Photometry\Intensity Distribution.
This file contains the C-Plane and G-Angle definitions.

**Example:**

```plaintext
OPTIS - Intensity Distribution sampling file v1.0
Example for IES C, Eulumdat and Optis intensity (Radio and Photo)
11 0 3 10 15 20 180 216 252 288 324 360
6 0 30 60 100 135 180
```

The first line gives the file type.
The second line is a comment.
The third and the fourth lines are the two angles sampling.
The first value is the sampling number and the following the samplings.
For the integration angle, the flux will be calculated as the average flux around the direction in a cone which is defined by the integration angle.

**Axis**

In the Axis group box, you must select one or more check boxes.
It is used to modify the orientation of the detector.

**Visualization Parameters**
You can select the Visualization radius check box.
Type or edit the value to change the radius of the sensor and intensity map displayed in the 3D view.

If you select Near field, the value of the near field radius is taken into account instead of the value set in Visualization radius.
Creating a 3D Map Detector

In OptisWorks, you can analyze the light on any surface of your system with a 3D map. This 3D map is defined by default with all the faces involved in the photometric simulation. You can define which faces are used as a 3D detector instead of using the whole system.

1. Click 3D Map Detector (Detectors).
   The PropertyManager appears.
2. Type a name in the 3D detector name box.
3. Click the faces in the graphics area.
4. Click OK.

In the OptisWorks tree, an .xm3 file is created and all the selected faces appear by double-clicking it.

The simulation results on a detector (.xm3 file) can be displayed with the XM3 Viewer.
You can edit, delete, suppress or unsuppress (see page 65) the detector.
You can show or hide the result in the 3D view (see page 65).
**3D Energy Density Detector**

**Creating a 3D Energy Density Detector**

This detector is used to compute the volumic absorption (Lumen/m³ or Watt/m³).

1. Click 3D Energy Density Detector (Detectors).
   
   The PropertyManager appears.

2. Type a name in the 3D Energy Density detector name box.

3. Set the parameters (see page 63).

4. Click OK.

   The detector appears in the OptisWorks feature tree in 3D Energy Density detectors.

   The simulation results of the detector (.vmp file) can be displayed with the VMP Viewer.

   You can edit, delete, suppress or unsuppress (see page 65) the detector.

   You can show or hide the result in the 3D view (see page 65).

   You can copy a detector (see page 65) in the same assembly or in another one.

**Parameters of a 3D Energy Density Detector**

**Axis System Definition**

To define the axis system, you must click three points in the graphics area.

It is used to define the orientation of the detector.

These three points give two vectors X and Y.

The vector Z is built by the product of X and Y.

The Z vector gives the axis of the detector.

**Type of Detector**

In the Type of detector box, you must click Photometric detector, Radiometric detector.

Clicking Photometric generate results with photometric units whereas clicking Radiometric generate results with radiometric units.

**Detector Size**

To define the size of the detector along the X, Y and Z directions, you must set a value in the X width (mm), Y width (mm) and Z width (mm) boxes.
Sampling
In the Sampling box, set a value in the X, Y and Z boxes.
The sampling is used to define the number of pixels of the VMP map.
X resolution, Y resolution and Z resolution correspond to the automatic calculation of the size of one pixel along X, Y and Z directions.

Parameters
Absorbed Energy/Energy density
You can click Absorbed energy or Energy density.
This parameter sets the type of data that are computed between energy density and absorption energy density.

Data Separated by Layer
By clearing the Data separated by layer check box, the simulation generates a BASIC XMP map (or a SPECTRAL map if the Colorimetric type is selected).
By clicking By source, the result includes one layer per active source.
Sources' power or spectrum can then be changed by using Virtual Lighting Controller present in Virtual Photometric Lab and Virtual Human Vision Lab.
By clicking By surface (SCA), the result includes one layer per surface selected using Surface Contribution Analyzer (see page 107) option.
By clicking By sequence, the result includes one layer per sequence selected using Stray Light Analysis (see page 114) option.
Detectors Management

Managing the Detectors in the OptisWorks Tree

1. Double-click Detectors.
2. If you want to edit the detector, right-click it, and then select Edit.
3. If you want to suppress or unsuppress the detector, right-click it, and then select Suppress or Unsuppress.
   If you want to suppress or unsuppress a detector in a case of a multi-configuration, you can choose if you want to apply this action to the current configuration, to all the configurations or to a selected list of configurations.

Showing or Hiding the Result in the 3D View

1. In the OptisWorks tree, double-click Detectors.
2. Right-click the detector and select Show Result In the 3D View or Hide Result In the 3D View.
3. According to the results, you can click:
   - Hide/Show XMP Results In The 3D View
   - Hide/Show XM3 Results In The 3D View
   - Hide/Show Camera Grid Results In The 3D View.
   You can view Photometric Results in Light Modeling (see page 100).

Copying and Pasting a Detector

1. In the OptisWorks tree, right-click the detector that you want to copy, and then select Copy.
2. In the OptisWorks tree, right-click where you want to paste the detector, and then select Paste.
   It can be the OptisWorks tree of the same assembly or one of another assembly.
   The PropertyManager appears with the data of the copied detector.
3. If the detector is on a rectangular surface, select another rectangular surface by clicking it in the graphics area.
4. If you copy the detector in a different assembly, redefine the geometrical references.
5. Click OK.
   The detector appears in the OptisWorks tree.
A Drag and Drop is also possible but only in the same assembly.
Additional Features

LCD Component
Creating a LCD Component

LuCid must be installed.

Creating a LCD component can only be done in an assembly.

With the LCD component, you can use the OptoPartner’s LuCid LCD stack in OptisWorks.
You can make the orientation by using the references in the assembly.
The LCD option is limited to OptisWorks Add-in 32 bits for 32 bits Operating System, OptisWorks Add-in 32 bits for 64 bits Operating System and OptisWorks Studio for 32 bits Operating System versions.
A tutorial to create a LCD Component is available.

1. Click LCD Component (Additional Features).
The PropertyManager appears.
2. Set the parameters (see page 67).
3. Click OK.
The LCD component appears in the OptisWorks tree.
The axis system appears as well as the display size.
4. If you want to edit a LCD component, right-click it in the OptisWorks tree, and then select Edit.
5. If you want to delete a LCD component, right-click it in the OptisWorks tree, and then select Delete.
6. If you want to suppress or unsuppress a LCD component, right-click it in the OptisWorks tree, and then select Suppress or Unsuppress.

If you want to suppress or unsuppress a LCD component in a case of a multi-configuration, you can choose if you want to apply this action to the current configuration, to all the configurations or to a selected list of configurations.

Parameters of a LCD Component

1. Type a name in the LCD component name box.
2. In the Axis system group box, you must set the parameters.
The axis system sets the position and the orientation of the LCD component in the space.
To select one point in the Origin box, and two lines in the X Direction and Y Direction boxes, click a point and two lines in the graphics area.
3. In the Files group box, you must set the parameters.
   1. In the LuCid File box, you must browse an .op_lbf file.
The LuCid file specific to LuCid contains the definition of the optical properties of the LCD and the surface geometry.
   2. In the Picture box, you must browse a .jpg or .png file.
The image file corresponds to the image displayed on the LCD.

3D Texture

Creating a 3D Texture

With the 3D texture, you can apply textures generated by two ways:
With the Pattern definition export tool for the geometry.
From another text file for the repartition.

A pattern for 3D texture (see page 80) and a mapping file must be created.
You can only apply a 3D texture on a volume and not on a surface.

1. In the file where you want to import the pattern, click 3D Texture (Additional Features).
   The PropertyManager appears.
2. Type a name in the 3D texture name box.
3. Click in the graphics area the faces on which you want to apply the pattern.
4. Set the parameters (see page 68).
5. Click OK.

If you want to create a 3D texture in a case of a multi-configuration, you can choose if you want to apply this action to the current configuration, all the configurations or a selected list of configurations.

Parameters of a 3D Texture

Axis System Definition

An axis system is defined by one point and two lines. Position, orientation, scaling of each pattern are defined for this axis system for the mapping file. For other mappings the xy plane is used as a reference for the offset. The xy plane is used as a reference for the pitch definition for the variable pitch mapping. The z direction is used to be the direction for the projection of the mapping filtering.

You must set the axis system.

- In the graphics area, click one point for the Origin or Csys box, and two lines for the X Direction box and the Y Direction box.
- Or-

- Select the Creo CSYS axis system in the Origin or Csys box.
  You can click Reverse direction to reverse the direction.

Pattern Definition

In the Pattern definition box, you must browse a .txt file (see page 80).

The pattern definition distributes the patterns within the system.

Mapping Definition

In the Mapping definition group box,

- You can select Mapping file and browse a .txt file.
  You can view the tutorial (see page 173) to create a mapping file.
Pattern Numbers: \(x\ y\ z\ ix\ iy\ iz\ jx\ jy\ jz\ kx\ ky\ kz\)

- The first line corresponds to the number of patterns that you are going to represent in the texture.
- \(x\ y\ z\): Coordinate of the pattern’s origin in the texture coordinate system.
- \(ix\ iy\ iz\): Orientation of the pattern with the respect of the X direction of the texture coordinate system.
- \(jx\ jy\ jz\): Orientation of the pattern with the respect of the Y direction of the texture coordinate system.
- \(kx, ky, kz\): Pattern scale values for respectively \(x, y, z\) directions. "1" value means 100% of the original pattern size.

- You can select other mapping (see page 69) types.

**Other Mappings**

In addition to the standard mapping file located in the project input folder, the mapping parameter allows several options in order to easily and automatically generate 3D texture distributions.

Four types of mapping are available: Rectangular mapping (see page 70), Circular mapping (see page 70), Hexagonal mapping (see page 71) and Variable pitches mapping (see page 72).

Each type describes a way to create a virtual grid that is going to be projected on a part’s surface.

1. A virtual grid is created using standard parameters (distance between patterns, mapping length...).
2. A Quilt or a Face is used to define the grid limitations.
3. All the patterns included in the limited grid are projected along the Z direction on the first encountered surface of the selected part.
4. A shift along Z could be applied on the projected patterns.
Rectangular Mapping

Mapping View

Following table describes mapping parameters.

<table>
<thead>
<tr>
<th>Pattern Direction</th>
<th>Position of the pattern (see page 73) according to different parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export</td>
<td>Export of the mapping file allowing creating an OPT3DMapping file.</td>
</tr>
<tr>
<td>Distance</td>
<td>Distance between patterns along X Direction</td>
</tr>
<tr>
<td>Mapping length</td>
<td>Mapping length along X Direction</td>
</tr>
<tr>
<td>Angle</td>
<td>Angle with X Direction</td>
</tr>
<tr>
<td>Distance</td>
<td>Distance between patterns along Y Direction</td>
</tr>
<tr>
<td>Mapping length</td>
<td>Mapping length along Y Direction</td>
</tr>
<tr>
<td>Angle</td>
<td>Angle with Y Direction</td>
</tr>
<tr>
<td>Quilt</td>
<td>Quilt or Face limiting the area (see page 72) on which the mapping is going to be created</td>
</tr>
<tr>
<td>Shift</td>
<td>Shift surface along Z Direction allowing an offset (see page 73) (optional)</td>
</tr>
<tr>
<td>Scale</td>
<td>Scale of the shift surface (optional)</td>
</tr>
</tbody>
</table>

Circular Mapping

Mapping View

Following table describes mapping parameters.

<table>
<thead>
<tr>
<th>Pattern Direction</th>
<th>Pattern Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export</td>
<td>Export of the mapping file allowing creating an OPT3DMapping file.</td>
</tr>
<tr>
<td>Radial distance</td>
<td>Radial distance between patterns</td>
</tr>
<tr>
<td>Mapping radius</td>
<td>Mapping radius</td>
</tr>
<tr>
<td>Distance</td>
<td>Distance between two rings</td>
</tr>
</tbody>
</table>
### Angle with X Direction
Quilt or Face limiting the area (see page 72) on which the mapping is going to be created

### Shift surface along Z Direction allowing an offset (see page 73) (optional)
Scale of the shift surface (optional)

### Pattern Direction
Position of the pattern (see page 73) according to different parameters

### Hexagonal Mapping

#### Mapping View

Following table describes mapping parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="icon" /> Export of the mapping file allowing creating an OPT3DMapping file.</td>
<td><img src="image" alt="icon" /> Hexagon length along X Direction</td>
</tr>
<tr>
<td><img src="image" alt="icon" /> Hexagon edge length along X Direction</td>
<td><img src="image" alt="icon" /> Hexagon length along Y Direction</td>
</tr>
<tr>
<td><img src="image" alt="icon" /> Distance between hexagons along X Direction</td>
<td><img src="image" alt="icon" /> Mapping length along X Direction</td>
</tr>
<tr>
<td><img src="image" alt="icon" /> Mapping length along Y Direction</td>
<td><img src="image" alt="icon" /> Angle with X Direction</td>
</tr>
<tr>
<td><img src="image" alt="icon" /> Angle with Y Direction</td>
<td><img src="image" alt="icon" /> Quilt or Face limiting the area (see page 72) on which the mapping is going to be created</td>
</tr>
<tr>
<td><img src="image" alt="icon" /> Shift surface along Z Direction allowing an offset (see page 73) (optional)</td>
<td><img src="image" alt="icon" /> Scale of the shift surface (optional)</td>
</tr>
<tr>
<td><img src="image" alt="icon" /> Pattern Direction</td>
<td><img src="image" alt="icon" /> Position of the pattern (see page 73) according to different parameters</td>
</tr>
</tbody>
</table>
Variable Pitches Mapping

Mapping View

Following table describes mapping parameters.

<table>
<thead>
<tr>
<th>Icon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Icon]</td>
<td>Export of the mapping file allowing creating an OPT3DMapping file.</td>
</tr>
<tr>
<td>![Icon]</td>
<td>X pitch curve</td>
</tr>
<tr>
<td>![Icon]</td>
<td>Scale of X pitch curve</td>
</tr>
<tr>
<td>![Icon]</td>
<td>Mapping length along X Direction</td>
</tr>
<tr>
<td>![Icon]</td>
<td>Angle with X Direction</td>
</tr>
<tr>
<td>![Icon]</td>
<td>Y pitch curve</td>
</tr>
<tr>
<td>![Icon]</td>
<td>Scale of Y pitch curve</td>
</tr>
<tr>
<td>![Icon]</td>
<td>Mapping length along Y Direction</td>
</tr>
<tr>
<td>![Icon]</td>
<td>Angle with Y Direction</td>
</tr>
<tr>
<td>![Icon]</td>
<td>Surface limiting the area (see page 72) on which the mapping is going to be created</td>
</tr>
<tr>
<td>![Icon]</td>
<td>Shift surface along Z Direction allowing an offset (see page 73) (optional)</td>
</tr>
<tr>
<td>![Icon]</td>
<td>Scale of the shift surface (optional)</td>
</tr>
<tr>
<td>![Icon]</td>
<td>Pattern Direction</td>
</tr>
</tbody>
</table>

X pitch curve must cut the yOz plane of the 3D texture 3D, and Y pitch curve must cut the xOz plane of the 3D texture.

For a correct construction of the 3D texture, the start point of the curve defining a variable pitch must be on the side of the origin of the axis system.

Mapping Filtering

Click the Mapping filtering icon ![Icon]

Following table describes Mapping Filtering View.
**3D Texture Mapping**

**Filtering with Flat Support**

**Shape Definition with OptisWorks**

**3D Texture Mapping**

**Filtering with Freeform Support**

---

**Mapping Offset**

Mapping offset 🌳 can be used to set a shift surface. With the shift surface, you can add an offset along Z direction on the projected patterns. Shift surface is not taken into account when surface is hidden.

---

**Pattern Direction**

You have two different ways to position the pattern.

- If you want to orientate the pattern according to the support of the 3D Texture, select Constant.
If you want to orientate the pattern according to the normal of the surface, select Normal to Support.

Pattern Scale

You can define three scale factors to set the size of each pattern independently on the 3 axes.

You cannot use the variable pattern scale if you selected the Mapping file (see page 68) type.

For each direction, you can set two parameters in X Scale, Y Scale and Z Scale.

- A surface. The scaling factor to apply to a specific mapping point is defined by the height of the point of this surface, at the corresponding coordinates (X,Y).
- A scale value, applied to all the patterns of a direction.

The pattern scale factors are cumulative to the global scale factor (Final pattern scale factor = global scale factor * pattern scale factor).
You can use scale factors as tolerancing or optimization variables.

Optical Properties
In the Optical Properties group box, you must browse a file in the Internal pattern material box, in the External pattern material box and in the Pattern surface quality box.

You can access the files in the Library folder, itself in the OPTIS folder.

The pattern material is the material which composes the texture.

Parameters
In the Parameters group box, to set the boolean operation, you must select a value from the Parameters list and a value from the Scale factor list.

Parameters

Boolean Operation
The following table describes the different Boolean Operation types.
For all the operations, you cannot create intersections between patterns.

There is an error if two volumes are intersecting or have tangent surfaces. Here, there will be red crosses.

A bypass for the regular modeling is the transparent file.

There is not an error if two volumes have in common a point or an edge thanks to the meshing. This is also true with 3D textures.

The earlier mentioned bypass does not work for 3D textures.

To avoid tangency issues, you can add an offset between the surfaces. The offset can be modeled:

- By the scaling variable of the 3D texture.
- By taking into account the offset when writing the mapping file.
- By modeling the pattern in a suitable scaling.
Add On
You cannot set tangent surfaces between patterns and a support.

When using the Add on boolean operation with a tangent surface, a gap is needed between the texture and this tangent surface.
The gap must be bigger than ten times the epsilon value.
You can view Parameters of Simulations (see page 89).

Add In
You cannot set tangent surfaces between patterns and a support.

Remove
You cannot set tangent surfaces between patterns and a support.

When using G for the small gap, you must set the propagation epsilon to G / 100 in the assembly preferences (ex: if G=1e-5 then Propagation epsilon=1e-7).
This gives fewer errors in the propagation of the photons.
The texture width cannot be larger than the material width.
Here, you must create two add on textures, one for each material side.
The diffuse supports and patterns are compatible with the operations as follows:

<table>
<thead>
<tr>
<th></th>
<th>Diffuse Support</th>
<th>Diffuse Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove</td>
<td>✅</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Add on Same Material</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Add on Different Material</td>
<td>✗</td>
<td>✅</td>
</tr>
<tr>
<td>Add In</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Insert</td>
<td>✅</td>
<td>✗</td>
</tr>
<tr>
<td>Layer</td>
<td>✅</td>
<td>✅</td>
</tr>
</tbody>
</table>
Add Layer

Add Layer
External pattern material: n1
Pattern material: n2

Add Layer
External pattern material: n2
Pattern material: n3

Add Layer
External pattern material: n4
Pattern material: n4

When the Add layer boolean operation is selected, the external pattern material must be selected. It is unavailable in all the other cases.

With the Add layer boolean operation, you can design multi-layers of 3D texture, each with different material (solar cell).

When the Add layer boolean operation is selected, the pattern must be designed as an open body (modelization with surfaces).

Example

Scale Factor
This global scale factor is cumulative to each pattern scale factor (Final pattern scale factor = global scale factor * pattern scale factor).
The value must be different from 0.
Then, the .txt file is:

- $x_1, y_1, z_1, i_{1x}, i_{1y}, i_{1z}, j_{1x}, j_{1y}, j_{1z}, k_1$
- $x_2, y_2, z_2, i_{2x}, i_{2y}, i_{2z}, j_{2x}, j_{2y}, j_{2z}, k_2$
- $x_3, y_3, z_3, i_{3x}, i_{3y}, i_{3z}, j_{3x}, j_{3y}, j_{3z}, k_3$

... **3 Scale Factors**

Each pattern can have three scale factors instead of one.

Both file formats are supported, with one or three scale factors inside.

This scheme describes the modification of the geometry of a pattern.

Then the .txt file is:

- $x_1, y_1, z_1, i_{1x}, i_{1y}, i_{1z}, j_{1x}, j_{1y}, j_{1z}, k_{1x}, k_{1y}, k_{1z}$
- $x_2, y_2, z_2, i_{2x}, i_{2y}, i_{2z}, j_{2x}, j_{2y}, j_{2z}, k_{2x}, k_{2y}, k_{2z}$
- $x_3, y_3, z_3, i_{3x}, i_{3y}, i_{3z}, j_{3x}, j_{3y}, j_{3z}, k_{3x}, k_{3y}, k_{3z}$

**Preview**

In the Preview group box, you must enter a value in the First pattern to display and Number of pattern to display boxes.

In case of high number of patterns displayed in the 3D view, the geometry manipulation can slow down.

By clicking Preview, you can preview an amount of patterns from an initial pattern.

You must type a value or use the arrows to change it in the First pattern to display box and in the Number of pattern...
When using the 3D textures, a BIN file is created.
With this pre-calculated file, you can improve the reading of a mapping file.
The used RAM memory is only related to the number of patterns (12*4*number of patterns plus something for the internal management).
There is no limit for the file's size.
The part containing the body support of a 3D texture can contain volumes but not any free surface.
Otherwise, the emitted ray from the source cannot be defined as initially being in or outside of the support.

**Defining a Pattern for 3D Texture**
A tutorial to create a 3D Texture (see page 171) is available.
1. Create a part.
2. To export the part as a pattern, click the OptisWorks menu, Additional Features, Pattern Definition Export...
   You can export the enabled geometry as a text file to be used as a texture.

**Polarization Plate Component**
Polarization plate is used to define polarization components like polarizers, wave plates, or any component whose Jones matrix is known.
Luminance detectors with direct simulation, gathering and fast transmission caustics with inverse simulation are not compatible with polarization plates or polarizers.

**Ideal Plates**
To define an ideal plate, you can select a standard from the list of proposed components, or give the Jones matrix of your component in a text file.
The plate has the same effect for any light ray because the Jones matrix is constant.

**Plates with Wavelength and Incident Angle Dependency**
Every polarization component, except depolarizing components, can be divided into a diattenuator and a retarder. For example, a linear polarizer is a diattenuator only and a quarter wave plate is a retarder only.
This decomposition is used to take wavelength and angle dependency into account.
The wavelength and angle dependency are only carried by the retarder because the retarder works on a principle of phase shift.
For plates with wavelength and angle dependency, you must define a retarder. This retarder requires accurate data on its optimal wavelength, the plate order and the birefringent material from which it is made.
Defining a diattenuator is optional but recommended.
In case you need to use the polarization plate with wavelength and incidence dependency in an inverse simulation, check in the simulation properties that is a Monte-Carlo simulation.

For more information, you can view the Setting Polarizer Surface (see page 243) tutorial.

Creating a Polarization Plate Component

1. Click Polarization Plate (Additional Features).
2. Set the parameters (see page 81).
3. Click OK.

The Polarization Plate appears in the specification tree and in the 3D view.

Parameters of a Polarization Plate Component

Polarization Plate Name
Type a name in the Polarization plate name box.

Axis System Definition
In the Axis system definition group box, you must set the parameters.

The axis system sets the position and the orientation of the polarization plate in the space.

To select one point in the Origin box, and two lines in the X Direction and Y Direction boxes, you must click them in the graphics area.

You can click Reverse direction to reverse the direction.

In many cases, the Jones matrix is different when the plate is illuminated on one side or on the other. To identify which side corresponds to the Jones matrix you are defining, take the local base of the plate. Your matrix is used for the plate illumination in the direction of the Z axis of this base, making an angle smaller than 90° with it. If light arrives from the other side (around -Z), the Jones matrix for the reversed component is automatically computed and used instead. If your Z axis is not in the general direction in which light is expected to travel, use the “Reverse direction” option for X or Y in order to modify Z. Note that for a retarder alone, the matrix remains the same when the plate is turned.

Geometry
In the X and Y group boxes, you can type or edit coordinates of the Start and End points of the plate rectangle.

You can select the Mirrored Extent check box to link the Start and End values and have light from all space.

Optical Properties
With this function, you can apply an external material to one or more selected faces only.

1. To select the faces that you want to modify, click them in the graphics area.
2. In the External Material box, browse a default material from the Library folder or a file you have created (.material files).

Any material which is set appears in the OptisWorks tree.

Under each material item, you can see the name of the parts in which they are applied.

You can double-click the part to open it or you can right-click it to display a shortcut menu.

By default, the photon is emitted in the external material.

If the emission is inversed, the internal material is used.

To get a coherent system when the surface is not closed, the internal and external materials must be the same.

Wavelength and Incidence Dependency
Before going further, you must decide if the plate has a dependency on wavelength and incident angle, that is if the plate is a polarizer or a retarder with a diattenuator. Select the Wavelength & incidence dependency check box according to the dependency you need.

- If you do not select Wavelength and incidence dependency, the Polarization field appears.
If you select Wavelength and incidence dependency, the Retarder and Diattenuator fields appear.

**Polarization**

In the Type group box, select a polarizer type:

- You can select Library....
  Select a file from the library or choose your own .polarizer file.
  You also can edit the file by clicking Edit...
  The axes specified in the file (lines 3 and 4) are not used. The axis selected with the mouse is used instead.
  For a rotated component, apply the rotation to the Jones matrix.
- You can select Linear polarizer (with principal axis along X of the local base).
- You can select Left circular polarizer.
- You can select Right circular polarizer.
- You can select Half wave plate (with fast axis along X of the local base).
- You can select Quarter wave plate (with fast axis along X of the local base).

**Diattenuator**

Defining the diattenuator is optional. If you define a diattenuator, it is placed before the retarder, considering the local Z direction.

A diattenuator is a component whose transmittance depends on the incident polarization.

- In the Diattenuator group box, select a diattenuator type:
  - You can select Library....
    Select a file from the library or choose your own .polarizer file.
    You also can edit the file by clicking Edit...
    The axes specified in the file (lines 3 and 4) are not used. The axis selected with the mouse is used instead.
    For a rotated component, apply the rotation to the Jones matrix.
  - You can select Left circular polarizer.
  - You can select Right circular polarizer.
  - You can select Linear Polarizer.
  - If you select Linear Polarizer, you can set the orientation angle of the polarizer in the Orientation spinbox.

**Retarder**

Defining the retarder is mandatory.

A retarder is a piece of birefringent material dephasing (i.e. retarding) the two orthogonal parts of the electric field one compared to the other.

In the Retarder group box,

1. In the File group box, click Select and browse a .material file.
   You also can edit the file by clicking Edit....
   The birefringent material is given by the .material file. It has to be an unaxial material. Two of the three refractive indices $na$, $nb$, $nc$ must be equal. For a positive material, $na = nb < nc$. For a negative material, $na < nb = nc$.
   If the three indices are not in increasing order, you will get an error.
   Vectors $I$ and $J$ are not used. The X direction you choose for the plate is the direction of $na$. The Y direction is the direction of the first index different of $na$, so that the extraordinary axis is always in the plane of the input face.
2. In the Optimal Wavelength (w) box, type or edit the wavelength value.
   The optimal wavelength is the wavelength for which the retarder plate has been designed.
3. In the Retardance group box, you must give the $N$ and $T$ values in front of $w^*$ and $+w/$, knowing that the total Retardance $= N \ast w + w / T$.
   $N$ must be an integer and $T$ a real number.
The plate will induce the retardance (in waves) given by $w/T$. For a quarter wave plate, $T=4$. If the plate is a multi-order wave plate, the order $N$ is defined so that the total retardance is $Nw+w/T$.

The plate thickness in mm is computed using the retardance and the refractive indices, and appears in the Thickness group box.
Ray Tracing

Launching a Ray Tracing

A source must be defined.

Using a ray tracing can only be done in an assembly.

A ray tracing source is a source which can emit some rays in the graphics area.

You can use the following sources for the ray tracing:
- Surface sources (see page 25)
- Ray file sources (see page 32)
- Interactive sources (see page 37)
- OLED sources (see page 37)

The ray tracing only runs for selected sources.

1. In the OptisWorks tree, double-click Sources, Photometric sources.
2. Right-click the source, and then select Switch On For The Ray Tracing.
3. Click Ray Tracing Complete Update (Ray Tracing).

A ray tracing is launched.

Or

- For an interactive source, right-click Interactive simulation, and then select Run.

A ray tracing is launched.

The ray tracing takes into account all the modifications.

Updating a Ray Tracing

A ray tracing must be launched.

With this function, you can view several rays tracing with the same properties.

- Click Ray Tracing Update (Ray Tracing).

A new ray tracing with the same properties is launched.

Showing or Hiding a Ray Tracing

A ray tracing must be launched.

- Click Show/Hide Ray Tracing (Ray Tracing).

Changing between a Photometric and an Interactive Source

An interactive source and a photometric source must be created.
A ray tracing must be launched.

With this function, you can generate a ray tracing from a photometric or an interactive source. You have simultaneous ray tracing from interactive sources.

1. In the OptisWorks tree, right-click the source, and then select Switch On For The Ray Tracing.
2. Click Source Switch (Ray Tracing).

Exporting Ray Tracing As A Geometry

You must have launched a ray tracing first.

With Ray Tracing Export As Geometry, you can export a ray tracing as a SolidWorks geometry.

You can export both classical optical sequence ray tracing and Light Path Finder ray tracing.

- Click Ray Tracing Export As Geometry (Ray Tracing).
A new 3D sketch is generated in the current assembly from the ray tracing.
Parameters of a Ray Tracing

Setting the Parameters for a Ray Tracing

1. In the OptisWorks tree, double-click Simulations.
2. Right-click Interactive Simulation, and then select Edit. The PropertyManager appears.
3. Set the parameters (see page 86).
4. Click OK.

Parameters of a Ray Tracing

Lines or Impacts
You can click Lines or Impacts to choose to display lines or to display impacts.

Rays without Errors
Selecting the Rays without errors check box displays rays without propagation errors during the interactive simulation.

Rays with Errors
Selecting the Rays with errors check box displays rays with propagation errors during the interactive simulation.
With this option, you can check when and where the propagation errors occur during the propagation. The main propagation error is in the definition of the internal and external materials.

TXT Export
You can select the TXT export check box.
It exports the interactive simulation as a text file.
With this option, a generation of an interactive simulation report can be found in Results manager.
The report shows the emitted photon, the impact, the emergent photon and the absorption characteristics.

• Emitted photon: Position (x, y, z), Direction (l, m, n), Wavelength w, Energy e.
• Impact: Object ID, Face ID, Position (x, y, z), Direction (l, m, n), Wavelength w, Energy e, Normal direction (l, m, n), refractive n1, refractive index n2, interaction type.
• Emergent photon: Position (x, y, z), Direction (l, m, n), Wavelength w, Energy e.
• Absorption: Position (x, y, z)

Max Impacts
You can type a value in the Max impacts spinbox.
It sets the maximum number of impacts in interactive simulations.

If the Max Impacts value of the simulation parameters is higher than the Max Impacts value of the interactive simulation, this last one limits the number of impacts of the interactive simulation. On the other hand, if the Max Impacts value of the simulation parameters is lower than the Max Impacts value of the interactive simulation, the number of impacts of the interactive simulation is set by the simulation parameters.
Light Expert - Ray Tracing Filtering

Generating a Ray Tracing Filtering

A ray tracing with an interactive source must be created.

The Ray Tracing Filtering is included in the Light Expert option.
When you have defined a source for ray-tracing (see page 37) in 3D view, you can analyze your system with an interactive ray tracing filtering.

With this function, you can select some faces of your system to display rays which are coming or not coming through these faces.

This function is a helpful tool for a light guide or a lamp analysis.

1. Choose required faces (see page 87) or rejected faces (see page 87).
2. Launch a ray tracing (see page 84).
3. In the OptisWorks tree, double-click Light Expert, Ray tracing filtering.
4. Right-click Required faces, and then select Or filtering option or And filtering option.

If you select Or filtering option (default option), the rays with almost one intersection with one of the selected faces list are displayed.
If you select And filtering option, the rays with one intersection with each face of the selected faces list are displayed.

Choosing Required Faces for a Ray Tracing

A source must be defined.

1. Click Required Faces (Ray Tracing).
   The PropertyManager appears.
2. Click in the graphics area the faces that you want to set as required faces.
3. Click OK ✓.

Choosing Rejecting Faces for a Ray Tracing

A source must be defined.

1. Click Rejected Faces (Ray Tracing).
   The PropertyManager appears.
2. Click in the graphics area the faces that you want to reject.
3. Click OK ✓.
Simulations

A simulation can only be done in an assembly.

When you run a simulation, it is important to check that:

- You have the necessary space on your hard disk for files that will be generated.
  For example, a ray file may be very large.
  1 Millions of rays take 30 Mb of space.
  An XMP map of 800x600 pixels and 10 wavelengths takes about 20 Mb.

- Your computer does not shut down during the simulation.

- You do not use a screen saver that consumes many CPU time and/or resources (like 3D box) –
  You must use a blank screen saver instead.

We also recommend you to save your assembly and parts before running a simulation.

If you use the Max facet width (see page 89) option, you must be aware than a small value can generate a large number of facets.

In most cases, if you do not need to generate a 3D map, the Deflection (see page 89) option is a better choice.

If you need to generate a 3D map, you must take care that the value of Max facet width is not too small.
Simulations Parameters

Editing the Simulation Parameters

An assembly must be open.

You can define some preferences which are stored in each assembly or part file. For an assembly, you can define the simulation and the results preferences.

The assembly preferences can be set up in the Simulations folder in the OptisWorks tree.

1. In the OptisWorks tree, double-click Simulations.
2. Select Simulation parameters, Direct simulation, Inverse simulation or Interactive simulation.
3. Right-click and select Edit.
   The PropertyManager appears.
4. Set the parameters (see page 89).
5. Click OK.

If you want to edit the simulation parameters in a case of a multi-configuration, you can choose if you want to apply the changes to the current configuration, all the configurations or a selected list of configurations.

Parameters of Simulations

For a simulation, you can define the simulation and the results preferences.

General Simulation Parameters

Save and Updates Calculation During...

- You can modify the periodic saves during the simulations in the Save and updates calculation during... group box by setting a value in the Elapsed time (mn) spinbox.
- You can select the directory where you want to store the simulation results by selecting the Output folder location check box.
  Enter the filepath to the directory in the field or browse to the directory with the browse button.
  With this option, you can store your results in a directory located on a server as well as in a local directory.
  If the last directory of the output folder location path is missing, a directory is automatically created when the simulation launches to save the results.
- You can select the Create one result folder per configuration check box to create a directory containing a simulation's results at the first update of this simulation.

Propagation

Ambient Material

The ambient material by default is the AIR.material.
You can browse another ambient material.

Propagation Epsilon

After an intersection on geometry, rays are propagated of this value in mm.
Then, the same face will be not detected as an intersection between a ray and a geometry.
The propagation epsilon value is limited to 10E-10 m.
For a 3D texture, a propagation epsilon value between 10E-5 and 10E-6 m is recommended.

Maximum Impact

After this number of interactions, the ray is considered as absorbed.

Stop Propagation if Photon Energy Is <

During the propagation, the photon energy is modified according to the absorption of the surface qualities and the materials.
When the photon energy is less than this value, the photons are considered as absorbed.
Smart Engine Parameter

This parameter is used by the Smart Engine which speeds up all the calculations with meshed geometry and must be modified with precaution.

The default value works for all the systems.

In some cases, you can increase the value of this parameter to speed up the simulation. Higher the parameter is, more the initialization takes time and takes memory.

However, after that, the simulations are quicker until a certain value (13 or 14).

Multi-Threading

With the multi-threading option, you can set the number of threads for the simulation. It detects automatically the number of threads available on your computer.

It is the default value.

Default Filtering for Non Spectral Map

This option defines the default filter applied on each non spectral generated map. The filtering algorithm modify the value of each pixel with the values of its neighbors. Value is equivalent to Pass number in the Virtual Photometric Lab and in the Virtual Human Vision Lab XMP filtering. Entering 0 means that you do not want filtering.

Default Filtering for Spectral Map

This option defines the default filter applied on each spectral generated map.

- None: no filtering.
- Standard: see Default filtering for non Spectral map.
- Remove highest peaks: removing high values that could be present on very noisy maps. If the value of a pixel is Threshold number of time higher or lower than the average value of its neighbors, a median filtering is applied to the pixel.

By clicking Remove highest peaks, the Threshold value is set by default to 4.

Value corresponds to Pass number in the Virtual Photometric Lab and Virtual Human Vision Lab.

Direct Simulation

You can see Parameters of a Direct Simulation (see page 92).

Inverse Simulation

You can see Parameters of an Inverse Simulation (see page 95).

Interactive Simulation

You can see the Parameters of an Interactive Simulation (see page 86).

The simulation folders are available per the SolidWorks configuration.

By right-clicking, in the OptisWorks tree, Direct Simulation, Inverse Simulation or Interactive Simulation, and then by selecting Edit, Suppress or Unsuppress, you can edit, suppress or unsuppress the item.

Library Path

You can define the Directory Preferences in the Labs, then the shortcuts in OptisWorks use these preferences. The network path can be used and it is better to close OptisWorks while editing the path within the Labs.

Simulations Compatibility

These are compatible sources and sensors with the different types of simulation.

<table>
<thead>
<tr>
<th>SIMULATIONS</th>
<th>SOURCES</th>
<th>DETECTORS</th>
</tr>
</thead>
</table>

OptisWorks Light Modeling User Guide
<table>
<thead>
<tr>
<th>SIMULATIONS</th>
<th>SOURCES</th>
<th>DETECTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Simulation (see page 92)</td>
<td>Surface Source (see page 25) &lt;br&gt;Ray File Source (see page 32) &lt;br&gt;Thermic Surface Source (see page 33) &lt;br&gt;Volume Source &lt;br&gt;Thermic Volume Source &lt;br&gt;Source Group (see page 40)</td>
<td>Illuminance Detector (see page 45) &lt;br&gt;Ray Map Detector (see page 52) &lt;br&gt;Intensity Detector (see page 56) &lt;br&gt;Polar Intensity Detector (see page 59) &lt;br&gt;3D Energy Density Detector (see page 63)</td>
</tr>
<tr>
<td>Inverse Simulation (see page 95)</td>
<td>Surface Source (see page 25) &lt;br&gt;Thermic Surface Source (see page 33) &lt;br&gt;Volume Source &lt;br&gt;Thermic Volume Source &lt;br&gt;Source Group (see page 40)</td>
<td>Illuminance Detector (see page 45) 1</td>
</tr>
</tbody>
</table>

1 Except with a Monte Carlo inverse simulation with a non-spectral illuminance detector.
Direct Simulation

Direct Simulation Overview

Direct simulation means that photons are emitted from the sources then propagated in the system.

With the direct simulation, you can get the following results:

- **Illuminance**
  This is the quantity of light (in Lux) which arrives on a detector from all the directions; it does not depend on the position of the observer.
  You can get the Illuminance on a 2D detector (see page 44) or directly on each surface of the system in a 3D map.

- **Ray file**
  All the rays which are going outside your system without being absorbed can be saved into a .ray file.
  This file can be used as a ray file source (see page 84) in another system.

- **Intensity**
  This is the intensity of light (in cd) which is going outside your system.
  You can display the intensity as an intensity diagram (3D display) or as a cartesian intensity map (2D display).
  There are standard formats to describe the intensity diagram (IES or Eulumdat).
  There are standard formats to describe the cartesian intensity map (SAE type A or B).

- **Luminance**
  This is the quantity of light (in cd/m²) that an observer receives when he looks at the system; it depends on the position of the observer.
  It gives the same result as a photometric camera.
  The luminance is displayed in a 2D plane which represents the screen of observation.
  There is a 2D map viewer to display the luminance.
  You can perform a spectrum and a colorimetric analysis on the luminance map.

Setting the Parameters for a Direct Simulation

1. In the OptisWorks tree, double-click Simulations.
2. Right-click Direct Simulation and select Edit.
   The PropertyManager appears.
3. Set the parameters (see page 92).
4. Click OK.

If you want to edit the simulation parameters in a case of a multi-configuration, you can choose if you want to apply the changes to the current configuration, all the configurations or a selected list of configurations.

Parameters of a Direct Simulation

**Number of Emitted Rays**

In the Number of emitted rays group box, you can choose the number of emitted rays and the unit.
You must set a value in the spinbox to set the number of emitted rays.
You must select a value from the list to choose the unit.
You can select Rays, Kilo-rays, Mega-rays or Giga-rays (10e3, 10e6 or 10e9).
The number of emitted rays can be greater than two Giga Rays.

**Detectors**

In the Detectors group box, you can select or clear the Luminance map gathering check box.
When selecting the Luminance map gathering check box, you improve the simulation performances.
It enables the map gathering which means that it aims at improving the convergence rate for the luminance detectors in the case of direct simulations.
When looking at a scene with a very small luminance map, if Luminance map gathering is not cleared, few rays have a chance of being integrated in the map. The map gathering tries to integrate all the rays hitting a scattering surface. When clearing the Luminance map gathering check box, the performances are equal to the older versions of OptisWorks 2008.

**Ray File Format**

A ray file can be saved with or without polarization data.

**With Polarization Data**

If you want to run a direct simulation with a polarization data, you must click With polarization data.

![Polarization Data Diagram](image)

**Polarization data:**

- $I$: Ellipse big axis normalized vector $(o, p, q)$
  
  3 float (such as $o^2 + p^2 + q^2 = 1$)

- $r$: Equal to $J/I$ (small axis divided by big axis)
  
  1 float ($0 \leq r \leq 1$)

- $s$: Right or left polarization
  
  1 float (0:right or 1:left)

$I$ is orthogonal to the photon direction $(l, m, n): l^*o + m^*p + n^*q = 0$

$J$ is orthogonal to $I$ and to the photon's direction.

So in the rays file, $(o, p, q, r, s)$ must be added to each ray.

**Without Polarization Data**

If you want to run a direct simulation without a polarization data, you must click Standard.
Optional Output Files
You can generate an output file by selecting the Ray file check box.
So, all the rays which are going outside your system without being absorbed can be saved into a .ray file.
This file can be used as a ray file source (see page 84) in another system.
The HTML report (see page 100) is automatically generated.

Ambient Sources
If you select the Enable ambient sources check box, you can use an ambient source with a direct simulation.

Display Warnings
You can select or unselect the Show Tessellation Errors check box to hide or show the error messages concerning tessellation during the simulation.

Running a Direct Simulation

One or more detectors must be defined. The parameters of the direct simulation must be set.

1. Click Direct Simulation (Simulations).
   Error: XX% corresponds to the evolution of the Total Error Number during the simulation.
2. If you want to stop it, click Simulation Stop (Simulations).
3. If you want to hide the simulation, click Progress Bar (Show/Hide) (Simulations).
4. If you want to display it after having hidden it, click Progress Bar (Show/Hide) (Simulations).
5. If you want to set the simulation priority below normal, click Simulation Priority Below Normal (Simulations).
6. If you want to set the simulation priority above normal, click Simulation Priority Above Normal (Simulations).
7. If you want to edit, suppress or unsuppress the simulation, in the OptisWorks tree, right-click the simulation, and then select Edit, Suppress or Unsuppress.
   -Or-
1. In the OptisWorks tree, double-click Simulations.
2. Right-click Direct simulation, and then select Run.
   Error: XX% corresponds to the evolution of the Total Error Number during the simulation.
3. If you want to stop it, click Simulation Stop (Simulations).
4. If you want to hide the simulation, click Progress Bar (Show/Hide) (Simulations).
5. If you want to display it after having hidden it, click Progress Bar (Show/Hide) (Simulations).
6. If you want to set the simulation priority below normal, click Simulation Priority Below Normal (Simulations).
7. If you want to set the simulation priority above normal, click Simulation Priority Above Normal (Simulations).
   All the geometry and the optical properties are transferred to the simulation kernel.
8. If you want to edit, suppress or unsuppress the simulation, in the OptisWorks tree, right-click the simulation, and then select Edit, Suppress or Unsuppress.
   Suppressing the simulation disables the Direct simulation icon.
**Inverse Simulation**

**Inverse Simulation Overview**

With the inverse simulation, you can get the luminance. It means that photons are emitted from the observer then propagated in the system. Luminance is the quantity of light (in cd/m²) that an observer receives when he looks at a system. It depends on the position of the observer. It gives the same result as a photometric camera. The luminance is displayed in a 2D plane which represents the screen of observation. There is a 2D map viewer to display the luminance. You can perform a spectrum and a colorimetric analysis on the luminance map.

The principle of the simulation is to give on a map the energy distribution seen from a viewpoint through a window (the map).

![View point](image)

**Luminance diagram**

When many luminance detectors are defined in the assembly, the inverse simulation computes the luminance maps for all the enabled luminance detectors.

When you include an illuminance detector in a non-Monte-Carlo inverse simulation, geometries are considered as absorbent.

Monochromatic sources are not compatible with the inverse simulations.

**Setting the Parameters for an Inverse Simulation**

1. In the OptisWorks tree, double-click Simulations.
2. Right-click Inverse Simulation, and then select Edit. The PropertyManager appears.
3. Set the parameters (see page 96).
4. Click OK.

   If you want to edit the simulation parameters in a case of a multi-configuration, you can choose if you want to apply the changes to the current configuration, all the configurations or a selected list of configurations.
Parameters of an Inverse Simulation

Monte Carlo

- Can generate noisy results
- Manages bulk diffusion
- Manages multiple diffuse inter-reflections
- Supports Light Expert analysis

**Gathering Source Number**

In inverse simulations, each ray is propagated from the observer point through the map and follows a random path through the system.

There is often a very small probability for a ray to hit a light source on its own.

To increase this probability, new rays are generated at each impact on diffuse surfaces.

These rays called shadow rays are targeted to each light source in the system and the program checks whether a direct hit on the sources is possible or not.

If not, nothing happens.

If the program finds a hit, it computes the corresponding radiance to store in the map.

The Gathering source number option pilots the number of shadow rays to target at each source.

**Maximum Gathering Error**

With this parameter, you reduce the simulation time for scenes with a large number of sources and where each source contributes to illuminate a small area of the scene.

This value defines the level below which a source can be neglected.

For instance, a value of 10 means that all sources contributing less than 10% to the illumination of all sources is not taken in consideration.

0, the default value, means that no approximation will be done.

You must take some precautions by using the Layer operations tool of the Virtual Photometric Lab.

For instance, if the Maximum Gathering Error option is defined at 1% for a simulation and if the flux of a source is increased ten times with the Layer operations tool, it means that the Maximum Gathering Error is now at 10% for this source.

**Fast Transmission Caustics**

When in the system, transparent objects of a scene are flat enough to neglect the refraction effect on the direction of a ray (Windows, Windshield, ...), the Fast Transmission Caustics check box can be selected to accelerate the simulation.

- The result is right only for flat glass (parallel faces).
- The convergence result is faster using the option.
- The effect of the refraction on the direction is not taken into account.
Determinist

- Avoids any noise
- Does not manage bulk diffusion
- Does not manage the diffuse inter-reflection
- Does not support Light Expert analysis

**Ambient Source Sampling**
The parameter defines the sampling.
The sampling is the quality of the ambient source.
The greater this value is, the better the quality of the result is but longer is the simulation.
The following table gives some ideas of the balance between quality and time.

<table>
<thead>
<tr>
<th>AMBIENT SAMPLING</th>
<th>REFERENCE TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMBIENT SAMPLING = 20</td>
<td>REFERENCE TIME / 3</td>
</tr>
<tr>
<td>DEFAULT VALUE AMBIENT SAMPLING = 100</td>
<td>REFERENCE TIME</td>
</tr>
<tr>
<td>AMBIENT SAMPLING = 500</td>
<td>REFERENCE TIME X 4</td>
</tr>
</tbody>
</table>

**Specular Maximum Impact Number**
This number defines the maximum number of specular interaction.
Specular Approximation Angle
For rendering purposes, it can be interesting to replace perfectly specular surfaces with a Gaussian. This gives better and faster results.

The typical application of this option is the rendering of automotive tail lamps lit appearance. For this application, a typical value would be 5 to 10 degrees.

Specular Approximation Angle affects transmission and reflection. In deterministic simulation, when rendering a tail lamp, it is a good practice to render the lit and the unlit appearances separately using a perfect mirror for the reflector when rendering the unlit appearance and using a Gaussian surface when rendering the lit appearance.

This option enables to achieve both lit and unlit appearance in a single simulation using a single specular material. The software detects the faces to convert to Gaussian automatically whenever needed.

In an inverse simulation, Gaussian surfaces and ambient sources does not provide good results due to the sampling technique used.

Anti-aliasing
By selecting the Anti-aliasing check box, you reduce artifacts as jagged profiles and fine details but increases the simulation time.

Display Warnings
You can select or unselect the Show Tessellation Errors check box to hide or show the error messages concerning tessellation during the simulation.

Running an Inverse simulation
One or more luminance detectors must be defined.

1. Click Inverse Simulation (Simulations).
2. Error: XX% corresponds to the evolution of the Total Error Number during the simulation.
3. If you want to stop it, click Simulation Stop (Simulations).
4. If you want to hide the simulation, click Progress Bar (Show/Hide) (Simulations).
5. If you want to display it after having hidden it, click Progress Bar (Show/Hide) (Simulations).
6. If you want to set the simulation priority below normal, click Simulation Priority Below Normal (Simulations).
7. If you want to set the simulation priority above normal, click Simulation Priority Above Normal (Simulations).
7. If you want to edit, suppress or unsuppress the simulation, in the OptisWorks tree, right-click the simulation, and then select Edit, Suppress or Unsuppress.

-Or-
1. In the OptisWorks tree, double-click Simulations.
2. Right-click Inverse simulation, and then select Run.
   Error: XX% corresponds to the evolution of the Total Error Number during the simulation.
3. If you want to stop it, click Simulation Stop \(\times\) (Simulations).
4. If you want to hide the simulation, click Progress Bar (Show/Hide) \(\square\) (Simulations).
5. If you want to display it after having hidden it, click Progress Bar (Show/Hide) \(\circ\) (Simulations).
6. If you want to set the simulation priority below normal, click Simulation Priority Below Normal (Simulations).
7. If you want to set the simulation priority above normal, click Simulation Priority Above Normal (Simulations).
8. If you want to edit, suppress or unsuppress the simulation, in the OptisWorks tree, right-click the simulation, and then select Edit, Suppress or Unsuppress.

Suppressing the simulation disables the Inverse simulation icon.

The number of passes depends on the defined precision in the luminance detector (see page 53). Then the following formula can be applied: \(\text{Precision} = \frac{1}{\sqrt{N}}\) with \(N\) the number of passes.

When stopping a simulation, it is possible to stop it, to finish it immediately with a reload of the saved map or to finish it just after the next pass.
Photometric Results in Light Modeling

Results in Tree
The photometric results are available in the OptisWorks tree, in the Result Manager folder. Each result can be displayed using a specific OPTIS Labs including other tools. You must only double-click a result in the OptisWorks tree, in Result Manager to run the corresponding OPTIS Labs. Clicking Compute targets calculates the map values and display them.

Output Files
Saving output files automatically creates an Output folder. The files are saved to the following path: .../Assembly Folder/Output/Configuration Name.
By double-clicking the result or by right-clicking it, and then by selecting Display result, you can run the corresponding OPTIS Labs: Virtual Photometric Lab for .XMP files, 3DMap viewer for .xm3 files, IES viewer for .IES files, Eulumdat viewer for .LDT files, OPTIS intensity viewer for .intensity files, Windows Internet Explorer for .html files.
3D View

2D irradiance and radiance results can be displayed in the 3D view.
You must right-click the detector in the OptisWorks tree, and then select Show Result In The 3D view.
After that, you must click Hide/Show XMP Results In The 3D View.

A 3D sensor result can be displayed in the 3D view.
You must right-click the detector in the OptisWorks tree, and then select Show Result In The 3D view.
After that, you must click Hide/Show XM3 Results In The 3D View.
Simulation Report Files

A HTML report is generated in the OptisWorks tree, in Result Manager, in the Simulation report files folder.

OptisWorks Direct Simulation Report

Duration: 49s

Power Report
- Number of generated photons: 1000000
- Number of radiated photons: 999968
- Number of absorbed photons: 0
- Number of stopped photons: 1
- Number of rays with error: 31 (0.0031%)

Radiometry
- Sources total power: 0.0136834 Watt
- Generated power: 0.0136634 Watt
- Radiated power: 0.0010182 Watt
- Absorbed power: 0.00266709 Watt
- Power of stopped photons: 6.09931e-009 Watt
- Error Power: 3.46203e-007 Watt

Photometry
- Sources total power: 1 Lumen
- Generated power: 1 Lumen
- Radiated power: 0.805002 Lumen
- Absorbed power: 0.194998 Lumen
- Power of stopped photons: 4.45744e-007 Lumen
- Error Power: 2.54470e-005 Lumen

Energy absorption

LED<1>red LED
- LED-1: 1.55333e-007 Watt, 1.21555e-005 Lumen
- Lguide-1: 0.00266772 Watt, 0.194956 Lumen

Sensors Report

C:\PROGRAM FILES (X86)\OPTIS\HELP\GETTING STARTED OPTISWORKS\L.GUIDE\OUTPUT\DEFAULT\SENSOR-1_002.xmp
C:\PROGRAM FILES (X86)\OPTIS\HELP\GETTING STARTED OPTISWORKS\L.GUIDE\OUTPUT\DEFAULT\3D DETECTOR-1_002.xmp

Geometry Report
- Number of faces: 17
- Number of triangles: 65374

Power Report
The report includes the emitted, absorbed and outgoing quantity of light in a radiometric and a photometric unit. The absorbed energy is given for each part in the assembly.

Energy Absorption
The energy absorption results are composed of the radiative exchange matrix.

Sensors Report
Hyper links to the simulation results per detector are available.
Managing a Multi Configuration Simulation

The multi configuration tool is the same for the direct and inverse simulations. All the compatible sources (see page 24) and detectors (see page 44) are available. In the OptisWorks tree, you can set the simulation parameters tree (see page 89). A sub folder is located in the results tree (see page 100).

1. Click the OptisWorks menu, Simulations, Multi configuration simulation...

-Or-

1. Click Multi Configuration Simulation... (Simulations).

   A box appears.

   In the Available simulations box, all enable direct or inverse simulations for all configurations appear. For example, for "Default/Direct", "Default" is the configuration's name and "Direct" the direct simulation's name.

   In the Selected simulations box, these are selected simulations for the multi configuration simulation.

2. To switch the elements from a box to another, select them, and then click the arrow or the arrow.

3. To run the simulations, click Run selected simulations.

In a case of a multi-configuration, when modifying some items, you can choose to apply the action to the current configuration, all the configurations or a selected list of configurations.

You can do that with the sources (see page 42), the 3D textures (see page 67), the LCD components (see page 67), the detectors (see page 65), the direct (see page 92) and inverse (see page 95) simulations, the general simulation parameters (see page 89), the tolerancing (see page 121), the optimization (see page 117) and the sequences of the stray light analysis (see page 114).
Light Expert

Light Path Finder

Light Path Finder Overview

The .lpf file is available for direct or inverse simulations. To use this feature, you must select a shape in a result (a photometric map) and see the complete light path from the source to this shape.

The ray tracing shows the propagation of the number of rays that you ask for. At this time, only the rays emitted by any sources and hitting the map appear. You can refine your analysis by defining a small shape in the map. Now, only the rays hitting the shape appear. You can move or resize the shape and the ray tracing is updated in real time, here in logarithmic scale.

The LPF is also compatible with the existing Ray tracing filtering tool. You can view Light Expert - Ray Tracing Filtering (see page 87). Here, the ray tracing only shows the light path of the rays emitted from the sources, hitting the selected faces and hitting the shape defined in the result map.

The Light Path Finder option is compatible with spectral maps and with maps with layers, maps with data separated by source or by surface.
It means that when you change the layer or the wavelength selection in the Virtual Photometric Lab, only rays matching the selection appear.

**Using Light Path Finder**

1. Define a detector with the LPF file option.
   - An illuminance, a luminance, a 3D energy density or an intensity detector can be used.
2. In the PropertyManager of the detector, under Parameters, select the Generate LPF file check box to generate a light path finder file for a detector.
   - The software saves an .lpf file for this detector.
3. Set a value in the Max paths spinbox.
   - For all the detectors generating xmp, the number of rays in the Max paths box can be different for the simulation.
4. In the OptisWorks tree, double-click Light Expert, Light Path Finder.
5. Right-click Parameters, and then select Edit.
   - The PropertyManager appears.
   - Set the parameters (see page 106).
6. Click OK.
7. Run the simulation.
8. At the end of the simulation, in the Light Expert OptisWorks tree, in the Result folder, you get the XMP map.
9. To open it, double-click it.

![Image](image-url)
10. If you select the Surface tool, the LPF is activated and the ray tracing is updated.

Parameters of Light Path Finder

Chooses the Display
Under Chooses the display, you must click Lines or Impacts.

Ray
You set a value in the Ray number spinbox.
Under Ray color, you must click True color or Choose color.
You can choose the color by clicking Choose color.

TXT Export
You can select or clear the TXT export check box.
If you select the TXT export check box, a text report is generated each time the ray tracing is updated.
You can see it in the OptisWorks tree in Default, itself in Results, itself in Light Path Finder, itself in Light Expert.
The report shows the emitted photon, the impact and emergent photon characteristics.

- Emitted photon: Position (x, y, z), Direction (l, m, n), Wavelength w, Energy e.
- Impact: Object ID, Face ID, Position (x, y, z), Direction (l, m, n), Wavelength w, Energy e, Normal direction (l, m, n), refractive n1, refractive index n2, interaction type.
- Emergent photon: Position (x, y, z), Direction (l, m, n), Wavelength w, Energy e.
You must set a value in the Max impacts spinbox.
Surface Contribution Analyzer

Surface Contribution Analyzer Overview

This feature is available for direct simulations. With this tool, you can generate a XMP map with one layer for each surface selected for the analysis. Then using the Virtual Photometric Lab, you can display and measure the contribution of each surface on the detector. This tool is useful for the reflector analysis. For example, if you have a system including a reflector and a lamp:

With a detector, you can get this type of result which gives you the illuminance of your system on the detector:

The Surface Contribution Analyzer option gives the same result. But, you can have the contribution of each surface that you have selected for the analysis. With the Surface Contribution Analyzer option, you can visualize the contribution of each photon that has been transmitted or reflected on the selected surfaces before reaching the detector.
Setting Surfaces for a Contribution Analyzer

1. Click Surface Contribution Analyzer (Detectors).
   The PropertyManager appears.
2. Click the faces in the graphics area.
3. Click OK.
   All the faces appear in the OptisWorks tree in the Surface contribution analyzer folder under Surfaces.

-Or-
1. In the OptisWorks tree, right-click Surfaces in Surface contribution analyzer, itself in Light Expert, and then select Edit Parameter.
   The PropertyManager appears.
2. Click the faces in the graphics area.
3. Click OK.
   All the faces appear in the OptisWorks tree in the Surface contribution analyzer folder under Surfaces.

Launching a Surface Contribution Analyzer

*You must have set surfaces for a contribution analyzer (see page 108).*

1. Define a detector with the LPF file option.
   An illuminance, a luminance, a 3D energy density or an intensity detector can be used.
2. In the PropertyManager of the detector, under Parameters, select the Data separated by layer check box.
3. Click By surface (SCA)
   You can view Parameters of a Surface Contribution Analyzer (see page 110).
4. Click OK.
5. Run a simulation.
   At the end of the simulation, in the OptisWorks tree, in the Result Manager folder, you get the XMP map.

Managing the Result

1. To open the result, double-click it.
   The XMP map consists of one layer for each selected surface.
   The name of each layer is given by the name of the face and the name of the component.
2. Select a layer from the list to get the contribution of a surface.

3. To display the Virtual Lighting Controller box, select User defined from the list of layers.

4. In the Virtual Lighting Controller box, select the check boxes corresponding to the surfaces that you want to display or clear the check boxes corresponding to the surfaces that you do not want to display.

Setting the Parameters of a Surface Contribution Analyzer

1. In the OptisWorks tree, in Surface contribution analyzer, itself in Light Expert, right-click Parameters, and then select Edit.
   
   Set the parameters (see page 110).

2. Click OK ✅.
Parameters of a Surface Contribution Analyzer

The Last Impact

The ray is integrated in the layer corresponding to a surface if the surface is the last one that the ray intersects before hitting the detector.

Otherwise, this ray’s contribution is integrated in the All other faces layer.
Intersected 1 Time
The ray is integrated in the layer corresponding to a surface if:

- the ray intersects the surface at least one time
- the last surface that the ray hits before the detector is not selected from the Surfaces list.

If one is respected but not two, the ray is integrated in the layer corresponding to the last surface.
Otherwise, the ray's contribution is integrated in the All other faces layer.
Stray Light Analysis

Stray Light Analysis Overview
This feature is available for direct and inverse simulations.
With the Stray Light Analysis option, you can visualize the contribution of each photon that has followed a parsed sequence before reaching the detector.
The Stray Light Analysis option is compatible with the Light Path Finder option to visualize the interactive ray tracing of each sequence in OptisWorks.
With this tool, you can generate in a first time a XMP map that will be used to calculate a number of optical sequences.
Then a second XMP map needs to be obtained that includes one layer for each sequence selected for the analysis.
Using the Virtual Photometric Lab, you can display, measure the contribution of each sequence on the detector and eventually get the signal to noise ratio of an optical system.
A tutorial to make a stray light analysis (see page 191) is available.

Defining Sequences for a Stray Light Analysis
1. Define a detector with the LPF file option.
   - An illuminance, a luminance, a 3D energy density or an intensity detector can be used.
2. In the PropertyManager of the detector, under Parameters, select the Generate LPF file check box to generate a light path finder for a detector.
   - The software saves an .lpf file for this detector.
3. Run a simulation.
   - At the end of the simulation, a new item appears in the OptisWorks tree in Result Manager.
4. To open the result, double-click it.
5. The Virtual Photometric Lab appears.
6. In the box, click Tools, Sequence Detection...
   - The Sequence detection box appears.
7. Type a value in the Max rays to parse box.
   - The Max rays to parse option corresponds to the number of rays to parse.
   - Only this number of rays can be analyzed.
8. Type a value in the Max sequences to keep box.
9. Click Parse.
   - The lists of interactions and sequences are filled.
10. To visualize the faces interacting with the parsed rays, select them by clicking an item in the List of interactions box.
    - A selected face is highlighted in the graphics area.
11. Select the sequences to analyze by double-clicking in the Selected boxes corresponding to the sequences that you want.
    - When a sequence is selected, Yes appears in the box.
12. Click Save.
    - If you want to define sequences in a case of a multi-configuration, you can choose if you want to apply this action to the current configuration, all the configurations or a selected list of configurations.

Launching a Stray Light Analysis
Sequences for a stray light analysis must be defined.
1. Right-click the detector in the OptisWorks tree, and then select Edit.
The PropertyManager appears.
2. Select the Data separated by layer check box, and then click By sequence.
3. If you want to visualize the interactive ray tracing of a selected sequence, select in the same time the Generates LPF file check box to generate a light path finder result.
5. Right-click Sequence definition, and then select Edit.
   The PropertyManager appears.
6. Browse the sequence in the Sequence file box.
7. Set the parameters (see page 115).
8. Click OK.
9. Run the simulation.
10. The result appears in the OptisWorks tree in Result Manager.

**Parameters of a Stray Light Analysis**

**Keep**
You can click Keep.
Each sequence selected in the first XMP map is placed in a layer.
The sequences that are not selected and those that are not parsed are placed in the All other sequences layer.

**Reject**
You can click Reject.
Each sequence selected in the first XMP map and those that are not parsed are placed in the All other sequences layer.
Each sequence that is not selected is placed in a layer.

**Managing the Result**
1. From the tree, double-click the .xmp file to open the result.
   The result includes one layer for each selected sequence.
The name of each layer is given by the name of the sequence.
Sequence 1 layer corresponds to the first detected sequence that contains the highest number of hits.

The bright spot at the center of the map is not obtained by this specific sequence.

2. Select a layer from the list to get the contribution of a sequence.

3. Select Other sequences. A portion of the bright spot that we are looking for appears.

   This layer corresponds to all the other sequences that have not been parsed during the sequence detection.

4. To display the Virtual Lighting Controller box, select User defined from the list of layers.

5. In the Virtual Lighting Controller box, select the check boxes corresponding to the sequences that you want to display or clear the check boxes corresponding to the sequences that you do not want to display.

   To visualize the interactive ray tracing of the All other sequences, you must right-click Sequence definition in the tree, and then select Suppress.

**Optimization**

With the optimization process, you can modify one or several parameters to reach a target.

Optimization variables can be defined with the optical parameters or with the dimensions.

Optimization targets can be defined with the optical calculation results or with the photometric results.

**Defining a Variable**

The optimization variables are defined in the Optimization / tolerancing Parameters folder in the OptisWorks tree.

**Defining an Optical Variable**

Right-click an optical variable in the OptisWorks tree and select Define as Optimization / Tolerancing variable.

You can also drag it in the OptisWorks tree to the Optical Variable folder, itself in Optimization / tolerancing Variables, itself in Optimization / tolerancing Parameters.

You can drag elements from the Optical Surfaces folder, the elements from the Photometric sources folder itself in the Sources folder and materials only from the Default part preferences folder.

When the optical parameter is in the Optical Variable folder, the new item appears.

**Defining a Mechanical Variable**

1. In the FeatureManager Design tree, double-click a sketch to display the dimensions in the graphics area.

2. In the OptisWorks tree, double-click Optimization / tolerancing Variables in Optimization / tolerancing Parameters.

3. Right-click Mechanical variables and select Add parameter.

   The PropertyManager appears.

4. In the Selection box, click a feature in the graphics area.

5. In the Dimensions and Parameters list, select one or more dimensions, constraints, or Optical Shape parameters.

6. Click OK.

**Modifying Variable Parameters**

1. Right-click an item in the Optical variables or Mechanical variables lists, and then select Edit parameter.

   Current value indicates the value the parameter currently has.

2. In the Minimum value and Maximum value boxes, type values.

   It corresponds to the minimum and maximum values used by the optimizer.

3. In the Precision box, type a value to evaluate if a new set of variables is identical to a previous one.

4. Click OK.

   If you want to remove an item, right-click it and select Remove this item.
Defining a Target

The optimization and tolerancing targets are defined in the Optimization / tolerancing Targets folder.

1. Right-click an optical target and select Define as Optimization / Tolerancing variable.

You can also drag an optical target in the OptisWorks tree from the Results Manager folder and drop it in the Optical targets folder or in the Photometric targets folder, itself in Optimization / tolerancing targets, itself in Optimization / tolerancing Parameters.

When the optical result is in the Optical targets folder, the new item appears.

The PropertyManager appears.

2. Type a name in the Target name box.

3. Set a value and weight in Optimization / tolerancing parameters.

   With the weight value, you can influence the overall merit function calculation.

4. Click Target parameters in the Target parameters box.

5. In the XMP Map Parameters dialog box, set the parameters.

   • From the Surface Type list, you must select a type.
     
     - If you select Rectangle, you must type values in millimeters in the Center X, Center Y, Height and Width boxes.
     
     - If you select Ellipse, you must type values in millimeters in the Center X, Center Y, Ray X and Ray Y boxes.
     
     - If you select Polygon, you must define the Point Number, and then type the X and Y values.
     
     - If you select Corona, you must type values in degrees in the Theta Min, Theta Max, Phi Min and Phi Max boxes.

1. Click OK.

2. Click OK.

3. If you want to edit the parameters, right-click the item, and then select Edit parameter.

4. If you want to remove the item, right-click it, and then select Remove this item.

   If you create a target of a certain type, you cannot create a second target of the same type as long as you have not modified or filled the content of the first target.

Setting the Optimization Parameters

1. Right-click Optimization, and then select Edit.

   The PropertyManager appears.

2. Set the parameters (see page 117).

3. Click OK.

   If you want to edit the optimization parameters in a case of a multi-configuration, you can choose if you want to apply the changes to the current configuration, all the configurations or a selected list of configurations.

Parameters of Optimization

   Optimization Engine

   • You can choose between two optimization algorithms in OptisWorks.

     - Evolutionary engine, based on a genetic algorithm.
     
     - Gradient engine, based on a gradient algorithm.

     Both algorithms use an iterative method.

     If you select both algorithms for the optimization, the genetic algorithm is going to be used to start the optimization and the gradient is going to be used at the end of the optimization, to obtain an accurate result.
• In the Time without improvement (mn) box, you can type or edit a value. The optimization can be stopped if the delay between two successive improvements of the merit function is greater than the parameter you define.

If both algorithms are used for the optimization, the genetic algorithm is used to start the optimization and the gradient is used at the end of the optimization to obtain an accurate result.

Optimization time without improvement can only be used for the Evolutionary engine optimization algorithm.

• You can select the Consecutive simulations without improvement check box, and type or edit the number of consecutive simulations without improvement.

You can set the Merit function improvement parameter. The Merit function improvement is a percentage based on the following calculation:

\[
\text{Improvement} = \frac{\text{Merit}_{t} - \text{Merit}_{\text{Best}}}{\text{Merit}_{\text{Best}}} \times 100
\]

• You can select Maximum time (mn) check box, and type or edit a value to define the maximum time taken by your optimization.

• You can select Maximum number of simulations check box, and type or edit a value to define the maximum number of simulations of your optimization.

Photometric Optimization

• You can choose between using a direct simulation or an inverse simulation during the optimization process.

• You can select the Keep intermediate results check box to save all intermediate results of the optimization process.

A subfolder is created with the name of the optimization function in the SPEOS output files directory. There is one result saved per iteration.

Merit Function

Minimize and Maximize Merit Function

The Minimize Merit function means that the aim of the simulation is to get the measurement as close as possible to the target value.

The Maximize Merit function means that the aim of the simulation is to get the measurement as far as possible from the target value.

With:

- Target: Optimization target
- Measure: Measured value of the target
- Weight: Weight of the target

Default and User Merit Function

The Default Merit function uses the previously described formulas.

The User defined Merit function uses Merit function you write in a VB script.

You can make references to targets' names.

If you make a mistake, for example by typing sqrt instead of sqr, an error message appears if you click Check. It returns the value of cos(1) in radians.
For more details, click Start, Programs, OPTIS, OPTIS Labs, Help to access VB Script Language Reference Help.

**Callback**

You can select Activate callback and browse a macro in the box, to run a macro between two iterations.

### Launching an Optimization

*To start the optimization, you must define one variable and one target first.*

You must set the simulation parameters.

- Parameters of a Direct Simulation (see page 92).
- Parameters of an Inverse Simulation (see page 96).

1. Click the OptisWorks Command Manager, Simulations, Optimization.
   
   A progress box appears during the optimization.

2. If you want to stop it, click Terminate.

   The maximum number of iterations is random.

   It depends on the convergence of the algorithm.

   At the end of the optimization, the optimization report appears.

   This report appears in the Tolerancing / Optimization folder.

   At the end, OptisWorks asks you if you want to replace your starting values with the best solution.

   If you click Yes, the system changes replacing your starting values with the values defining by the optimization.

   If you click No, the system does not change, but you can see the results of the optimization in the report.
**Tolerancing**

With the tolerancing process, you can modify one or several parameters to calculate a target value. Tolerancing variables can be defined with the optical parameters or with the dimensions. Tolerancing targets can be defined with the optical calculation results or with the photometric results.

**Defining a Variable**

The optimization variables are defined in the Optimization / tolerancing Parameters folder in the OptisWorks tree.

**Defining a Variable**

The optimization variables are defined in the Optimization / tolerancing Parameters folder in the OptisWorks tree.

**Defining an Optical Variable**
Right-click an optical variable in the OptisWorks tree and select Define as Optimization / Tolerancing variable.

You can also drag an optical variable in the OptisWorks tree to the Optical Variable folder, itself in Optimization / tolerancing Variables, itself in Optimization / tolerancing Parameters.

You can drag elements from the Optical Surfaces folder, the elements from the Photometric sources folder itself in the Sources folder and materials only from the Default part preferences folder.

When the optical parameter is in the Optical Variable folder, the new item appears.

**Defining a Mechanical Variable**

1. In the FeatureManager Design tree, double-click a sketch to display the dimensions in the graphics area.
2. In the OptisWorks tree, double-click Optimization / tolerancing Variables in Optimization / tolerancing Parameters.
3. Right-click Mechanical variables and select Add parameter.
   
   The PropertyManager appears.
4. In the Selection box, click a feature in the graphics area.
5. In the Dimensions and Parameters list, select one or more dimensions, constraints, or Optical Shape parameters.
6. Click OK ✅.

**Modifying Variable Parameters**

1. Right-click an item in the Optical variables or Mechanical variables lists and select Edit parameter.
   
   Current value indicates the value the parameter currently has.
2. In the Minimum value and Maximum value boxes, type values.
   
   It corresponds to the minimum and maximum values used by the optimizer.
3. In the Tolerancing laws box:
   
   - You can select Fixed to define a constant step between minimum and maximum values.
     
     If you select Fixed, you need to set the Step parameter.
     
     Step number corresponds to the number of calculation done in the variable range definition.
   - You can select Gaussian to get a finer step variation around a defined nominal value.
     
     If you select Gaussian, you need to set the Step, Nominal value and FWHM value parameters.
     
     Nominal value corresponds to the maximum value of the Gaussian distribution.
     
     FWHM value is the Full Width at Half of the Maximum of the Gaussian distribution.
   - You can select Quasi Monte Carlo to get a random variation between minimum and maximum values.
     
     If you select Quasi Monte Carlo, you need to set the Step parameter.
4. Click OK ✅.

If you want to remove an item, right-click it and select Remove this item.

**Defining a Target**

The optimization and tolerancing targets are defined in the Optimization / tolerancing Targets folder.
1. Right-click an optical target and select Define as Optimization / Tolerancing variable.
   You can also drag an optical target in the OptisWorks tree from the Results Manager folder and drop it in the Optical targets folder or in the Photometric targets folder, itself in Optimization / tolerancing targets, itself in Optimization / tolerancing Parameters.
   When the optical result is in the Optical targets folder, the new item appears.
   The PropertyManager appears.
2. Type a name in the Target name box.
3. Set the min value and max value in Optimization / tolerancing parameters.
   It corresponds to the range in which a value is valid.
4. Click Target parameters in the Target parameters box.
5. In the XMP Map Parameters dialog box, set the parameters.
   - From the Surface Type list, you must select a type.
     - If you select Rectangle, you must type values in millimeters in the Center X, Center Y, Height and Width boxes.
     - If you select Ellipse, you must type values in millimeters in the Center X, Center Y, Ray X and Ray Y boxes.
     - If you select Polygon, you must define the Point Number and type the X and Y values.
     - If you select Corona, you must type values in degrees in the Theta Min, Theta Max, Phi Min and Phi Max boxes.
1. Click OK ✓.
2. Click OK ✓.
3. If you want to edit the parameters, right-click the item and select Edit parameter.
4. If you want to remove the item, right-click it and select Remove this item.

**Setting the Tolerancing Parameters**
1. Right-click Tolerancing and select Edit.
   The PropertyManager appears.
2. Set the parameters (see page 121).
3. Click OK ✓.
   If you want to edit the tolerancing parameters in a case of a multi-configuration, you can choose if you want to apply the changes to the current configuration, all the configurations or a selected list of configurations.

**Parameters of Tolerancing**
- You can choose between using a direct simulation or an inverse simulation during the tolerancing process.
- You can select the Keep intermediate results check box to save all intermediate results of the tolerancing process.

   A subfolder is created with the name of the tolerancing function in the SPEOS output files directory. There is one result saved per iteration.

**Launching a Tolerancing**
*You must set the simulation parameters.*

Parameters of a Direct Simulation (see page 92).
Parameters of an Inverse Simulation (see page 96).
To start the tolerancing, you can define one or several variables, but only one target.
1. Click Tolerancing (Simulations).
   A progress box appears during the tolerancing.
2. If you want to stop it, click or click Cancel.
-Or-
1. In the OptisWorks tree, right-click Tolerancing, and then select Run.
   A progress box appears during the tolerancing.
2. If you want to stop it, click or click Cancel.
   At the end of the tolerancing, the tolerancing report appears.
   This report appears in the Tolerancing / Optimization folder.
Analyzing an Optical System with Light Modeling

You must have the LM2 package.

With this tutorial, you are about to design a L guide from scratch, setup sources and sensors, perform a ray tracing analysis and run photometric simulations.

1 hour 30 minutes

Lesson 1: Setting Up the Assembly

With this lesson, you are about to learn how to code the architecture of your project. You are going to draw a top assembly with two parts: the L guide and the source.

1. Open OptisWorks.
2. Click New.
3. Select Assembly.
4. Click OK.
5. To close the Begin Assembly PropertyManager, click Cancel.
6. Save the assembly in a folder by clicking File, Save As... You can save it as Lguide.
7. Click Insert, Component, New Part...
8. In the FeatureManager design tree, select Front Plane. It defines this front plane as the front plane of the part.
9. Save the new part as the Lguide part. The part appears in the FeatureManager design tree.
10. Exit from the Sketch mode by clicking .
11. Click to clear Edit Component.
12. Repeat the operation to create another part named LED.
13. Save your assembly and parts by clicking File, Save All.

Lesson 2: Coding the Lguide Geometry

1. In the Feature Manager design tree, right-click the Lguide part, and then select Edit Part.
2. Click Sketch.
3. In the FeatureManager design tree, in the Lguide part, select Front Plane. You are about to create a sketch in this plane.
The Sketch mode is activated.

4. If needed, select the Front view.

5. Click Line.

6. In the PropertyManager, if it is cleared, click As sketched.

7. Draw the following Lguide.

   If you are not familiar with SolidWorks, you can go to How to draw your LGuide to learn how to draw this L guide.

   You must be sure to obtain this black sketch which is completely constrained. When the sketch is completely black, it is completely constrained.

8. Click

9. Save all by clicking File, Save all.
10. To go back to the sketch, in the FeatureManager design tree, right-click Sketch, and then select Edit Sketch.

11. Click Point, and then insert a point in the middle of the output segment.

12. Click the arrow, next the Line tool, and then click Centerline.

13. Insert a center line perpendicular to the segment.

14. Press ESC, and then use the Smart Dimension tool to define a length of 5 mm.

15. Repeat the operation for the middle of the input segment (point, center line, dimension) setting the dimension to 20 mm.

16. Exit from the Sketch mode by clicking Exit Sketch.

17. Save your files.

18. Open the Lguide part to access the Features tab.
19. Click Features, Extruded Boss/Base.

20. Select your sketch in the FeatureManager design tree.

21. Set up the extrusion as follows.

22. Click OK ✓.
23. Right-click the Lguide part, and then select Change Transparency to display the Lguide.

24. Save, and then close the part.
25. Go back to the Lguide assembly.

**Lesson 3: Coding the LED Geometry**

1. In the FeatureManager design tree, right-click the LED part, and then select Edit Part.
2. Select Right Plane in the FeatureManager design tree.
3. Click Sketch.
4. Click the Normal To tool to optimize your view.

4. Click the Normal To tool to optimize your view.

You can use the mouse to orientate your sketch as follows.

5. Draw a circle centered on the origin, and then validate in the PropertyManager by clicking OK.

6. Draw a rectangle around the circle, and then validate.

You must be sure to have the same constraints.
7. Make a zoom on the circle by rotating the IntelliMouse wheel.
8. Draw the rectangle's diagonal by using the Centerline tool.
9. Get the mid-point of the diagonal by using the Point tool.
10. Click this mid-point.
11. Press CTRL, and then click the origin of the sketch.
   The PropertyManager appears.
12. Click Coincidence to apply a coincidence constraint between the center of the diagonal and the origin of the sketch.
13. Validate.
14. Save your LED part.
15. Apply dimension constraints to get the sketch turning black.
When the sketch is black, it is completely constrained.

16. Exit from the Sketch mode.
17. Click Features.
18. Click Extruded Boss/Base, and then apply to the outer square as follows.

You must be sure to have the square's extrusion in the inverse direction of the Lguide part. You can use the following arrow to inverse the direction of the extrusion.

19. Click OK ✓.
20. Click Features.
21. Click Extruded Boss/Base, and then do the extrusion for the inner circle.

22. If needed, use the following arrow to inverse the direction of the extrusion.

   The circle’s extrusion must to be toward the Lguide part.

23. Click Edit component to switch to the Assembly mode.

24. Save your files, and then to rebuild your parts and assembly, click Rebuild.

25. View your sketch.

26. Click Yes.
27. Click Zoom to Fit to make a zoom on your assembly, and then click Mate.

28. Click the two following points to apply a mate between them.

29. Validate.

30. Set a second constraint in the next box displayed in the PropertyManager.

   You must be aware to select the Parallel mate.
31. Set this third constraint.

32. Validate, and then close the box.

The LED part is now completely constrained in the 3D space.
Lesson 4: Checking the Optical Properties

The optical properties are saved in a part context.

1. Check the default material and the surface properties in the OptisWorks tree.

2. Select the LED part, and then click Part Preferences (Optical Properties).
   The PropertyManager appears.

3. To replace the default surface quality "Optical Polished" with "Perfect Absorber", browse the Mirror_000_percent_absorption.perfectmirror file.
Lesson 5: Creating a Photometric Source

The photometric properties are applied in a part context.

1. In the FeatureManager design tree, right-click the LED part, and then select Open Part to open it.

2. Click Surface Source (Optical Properties).

   The PropertyManager appears.

3. Select the circle as the emissive face by clicking it in the graphics area.

4. Define the source as follows.
5. Click OK ✓.
6. Save.
7. Exit.

You can use the True color within the Color box to get for example the red color for the RED LED source. The True color option is only usable with a monochromatic source.

**Lesson 6: Using a Ray Tracing**

The ray tracing is the first step for a design analysis. It shows the behavior of the system.

**Creating a Ray Tracing**
1. To visualize the ray path inside the Lguide part, right-click the part, and then select Change Transparency.
2. Launch the ray tracing by clicking Ray Tracing Complete Update (Ray Tracing).

**Showing or Hiding a Ray Tracing**
Click Ray Tracing (Show/Hide) (Ray Tracing).
Choosing Required Faces in a Ray Tracing

You must have the LXP Option.
Before choosing the required faces, you must delete the rejected faces in the specification tree.

With the LXP Option and by using the Ray tracing filtering tool, you can include faces to visualize stray reflections.

You can choose required faces to visualize the useful rays only.

1. Click Required Faces (Ray Tracing).
2. Click the faces you want to set as required faces in the graphics area.
3. Click OK.

The following window appears.

4. If you want to check the effect of the required faces, launch a ray tracing by clicking Ray Tracing Complete Update (Ray Tracing).

Rejecting Faces in a Ray Tracing

You must have the LXP Option.
Before creating the rejected faces, you must delete the required faces in the specification tree.

You can reject faces to visualize the useful rays only.

1. Click Rejected Faces (Ray Tracing).
2. Click the faces you want to reject in the graphics area.
3. Click **OK**.

4. If you want to check the effect of the rejected faces, launch a ray tracing by clicking Ray Tracing Complete Update (Ray Tracing).

**Lesson 7: Creating an Interactive Source**

With this lesson, you learn how to create an interactive source. With an interactive source, you can analyze preliminary analysis the system by doing a ray tracing.

1. In the assembly, create an interactive source by clicking Interactive Source (Ray Tracing).

   The PropertyManager appears.

2. In the PropertyManager, select Face-Face from the Source Type list.

3. Type Interactive source in the Source name box.

4. To define a source under Start in the box, click the circular face of the LED in the graphics area.
5. Type 5 or use the arrows to set the value at 5 in the U Sampling box and in the V Sampling box.

6. To define the end of the emission, under End in the box, click the rectangular entry face of the Lguide in the graphics area.

7. Type 5 or use the arrows to set the value at 5 in the U Sampling box and in the V Sampling box.
8. Type 550 or use the arrows to set the value at 550 in the Wavelength box.

9. Click OK ✓.
   You can change the color of the interactive source by changing its wavelength.

Lesson 8: Creating an Interactive Simulation

1. Click Source switch (Ray Tracing).
   The interactive sources are selected.
2. Launch a ray tracing by clicking Ray Tracing Complete Update (Ray Tracing).

The red crosses correspond to the rays with errors. In this example, these rays are the ones hitting the edges or the corner of the L guide. You can choose not representing them by clicking to clear the Rays with errors check box in the interactive simulation parameters.

Lesson 9: Coding the Detector Geometry

With this lesson, you learn how to code the detector geometry to be able to visualize the flux on an output surface.
1. In the assembly, hold down Ctrl and select the following point from the Lguide output.

2. Click Reference Geometry, Plane.
   A new plane is created.

3. Click Sketch to create a sketch.
4. Switch to the Normal To view.

5. With the Centerline tool, draw two axes from the middle point.

6. Get out from the sketch
7. Rename your sketch as Output Map.
8. Exit from the sketch, and then save your file.

Lesson 10: Defining a Photometric Map

Once the sensor surface is created, it must be placed close to the output face of the Lguide.

1. Click Illuminance Detector (Detectors).
2. Set the parameters as follows.
The Z axis must be:
For Light: In the same direction than the Light.
For Intensity: In the same direction than the Intensity.

3. View the OptisWorks tree.
   A new map appears when double-clicking Detectors, Illuminance/Irradiance detectors, 2D maps.

**Lesson 11: Launching a Simulation**

After a ray tracing analysis, you can do a photometric simulation.
1. In the OptisWorks tree, double-click Simulations.
2. Right-click Direct simulation, and then select Edit.
   The PropertyManager appears.
3. Under Number of emitted rays, set something like 10 000 emitted rays,
4. If your computer is strong enough, set one million of emitted rays.
5. Click OK ✓.
6. Click Direct simulation 🕹️ (Simulations).
   A progress bar appears.
7. Time is estimated to one minute
6. In the OptisWorks tree, double-click Results Manager, Photometric results, Illuminance/Irradiance results, 2D maps, DEFAULT.
   A box appears.
9. Click Tools, Surface ....
10. Maximize the selection zone.
11. Read the input flux.

The power balance for the system is superior to 50%.
Using a Ray File Source

You must have the LM1 or the LM2 package.

15 minutes

Using a Ray File Source with the Option Geometries

   This file is located in OW_Tutorials_Ray_File_Source.zip

2. In the FeatureManager Design tree, right-click the Bulb part, and then select Open Part.

3. Click Ray File Source (Optical Properties).


5. Under Axis system, click 1 point - 2 lines.

6. Select, by clicking them in the graphics area, the following elements as shown on the picture below:
   - The origin of the part as Origin,
   - The axis along Z direction of the part as X Direction,
   - The axis along X direction as Y Direction.

   You must check that the red-circled XYZ system is the same as the one showed.
   The Z axis is in the same direction than the bulb’s axis.
   If necessary, you can select the Reverse direction check box.

7. Under Exit geometries, to select the external faces of the bulb as geometries, click them in the graphics area.
The exit geometries selection modifies the start position of the rays, but not the direction.

8. In the Ray file name box, under Photometry, browse the Rays.ray file. It is located in the OptisWorks Inputs folder.

9. Click OK.
   The new source created appears in the OptisWorks tree.

10. In the Bulb part, click Rebuild.
11. Click File, Save.
12. Close the Bulb part.
13. Click Rebuild and save the RayFileSource assembly.
   The ray tracing appears.

The Bulb part is taken into account during the propagation except at the emission step.
Deleting the Option Geometries
1. Right-click the ray file source, and then select Edit.
   The PropertyManager appears.
2. Delete the selected geometries by right-clicking in the Geometries box, and then by selecting Clear Selections.
3. Click Rebuild.
4. Click File, Save.
5. Save.
6. Close the Bulb part.
7. Click Rebuild, and then save the RayFileSource assembly.
8. Click Ray Tracing Complete Update (Ray Tracing).

Creating a White LED Source from OSRAM Ray File

You must have the S_OWX_LM2, S_OWX_LM3 or S_OWX_LM4 solution.

With this tutorial, you will learn how integrate OSRAM ray-file for setting a white LED source.

45 minutes

Lesson 1: Downloading Data
1. Go to the OSRAM Opto-Semiconductors website (http://www.osram-os.com/osram_os/en/).
2. Open the Products menu and click Product Catalog.
   A new windows for web page of OSRAM Opto Semiconductors appears.
3. Select the Application support section and click Optical simulation.
   All OSRAM LED ray-files are available in this section.
4. From the list on the left, click:
   1. LED (Light Emitting Diodes).
   2. OSRAM OSTAR.
5. From the middle list, click:
   1. OSRAM OSTAR Headlamp,
   2. LEUW_U1A5_01,
3. rayfile_LEUW_U1A5_01_061212_Speos.zip.
6. Click I agree on disclaimer and save on your local directory.
7. Extract the files.
8. On the top ribbon, click Products.
9. From the list on the left, click:
   1. LED (Light Emitting Diodes).
   2. OSRAM OSTAR.
10. From the middle list, click:
    1. OSRAM OSTAR Headlamp,
    2. LEUW_U1A5_01,
    3. LEUW_U1A5_01 - OSRAM OSTAR Headlamp Pro of the datasheet.
11. Save the datasheet on your local directory.
12. Open OptisWorks.
13. Open LEUW_U1A5_01_061212_geometry.STEP file.
    A pop-up which proposes to run import diagnostics tools appears.
14. Click No.
    A pop-up which propose to run a feature recognition appears.
15. Click No.
16. Right-click on Imported1 feature, and select Feature Properties.
17. Rename it as LED_body.
18. Click OK.
19. Save the part as LEUW_U1A5_01.sldprt.

Lesson 2: Creating and Applying LED Optical Properties
1. Open LEUW_U1A5_01_061212_info.pdf from extracted folder.
2. Search and read the second section relative to the General properties of the rayfile at page 2.
   This section warns you about the use of CAD model, which is only provided to ease mechanical design. You must keep in mind that the CAD model must not be taken into account during the optical simulation.
3. From the OptisWorks tree, right-click the Part Preferences node and select Edit.
4. Click Browse of Surface quality.
5. Click Library and select Surface folder.
6. Select absorber.perfectmirror.
7. Click Open.
8. Click OK.
9. Click Save.

Lesson 3: Preparing the OSRAM Ray File of the White LED
For each white LED, OSRAM provides ray-files with different resolution (number of rays). LED emission is split into two files, for:
   - the blue emission of LED,
   - the yellow emission of the LED.
Adjusting blue and yellow emission allows to model the LED binning. You can also adjust the global flux to take the LED rank into account. Finally, you can set the output flux in order to take the functioning condition into account.

In this example, you are going to model LED LE_UW_U1A5_01-6R-ebvF68.

1. From the extracted folder, open LE_UW_U1A5_01.pdf LED datasheet file.
2. Search minimum and maximum of luminous flux for rank 6R at page 5.
3. Calculate the average luminous flux from maximum and minimum.
   The average luminous flux for brightness group 6R is 1325lm.
4. Close the datasheet.
5. From the extracted folder, open LEUW_U1A5_01_061212_info.pdf.
6. Search the blue and yellow contribution of binning ebvF68 at page 5.
   In luminous units, the yellow emission represents 94.4% of LED flux and the blue emission 5.6%.
7. Close the information file.
8. Compute the luminous flux of the blue and yellow emissions.

\[ \Phi_{\text{blue}} = \Phi_{\text{total}} \times \eta_{\text{blue emission}} \]
\[ \Phi_{\text{yellow}} = \Phi_{\text{total}} \times \eta_{\text{yellow emission}} \]

For LED LED LE_UW_U1A5_01-6R-ebvF68, the blue emission is 74.2lm and the yellow emission is 1250.8lm. This output flux is the flux if your LED is used in condition described in the datasheet.

For some reason, the current is set to 800mA. Then output flux is now different.
9. Open LE_UW_U1A5_01.pdf LED datasheet file from extracted folder.
10. Search the relative luminous flux in function of the current curve at page 9.
11. Evaluate the luminous flux at If = 800mA.
    Luminous flux is about 85% of average flux at If = 1000mA.
12. Close the datasheet.
13. Compute luminous flux of the blue and yellow emissions.

\[ \Phi_{\text{blue}} = \Phi_{\text{total}} \times \eta_{\text{blue emission}} \times \eta_{\Phi@I_f} \]
\[ \Phi_{\text{yellow}} = \Phi_{\text{total}} \times \eta_{\text{yellow emission}} \times \eta_{\Phi@I_f} \]

For LED LED LE_UW_U1A5_01-6R-ebvF68, blue emission is 63.1lm and yellow emission is 1063.2lm.

This output flux is set for If = 800mA. At this functioning point, chromaticity coordinate changes, see Chromaticity coordinate shift curve at page 9. It exists unfortunately no relation between chromaticity coordinate and ration of blue / yellow emission. Light perception could be slightly different from the colorimetry simulation.

14. Open ray-files rayfile_LEUW_U1A5_01_blue_5M_061212_Speos.RAY.
15. Select Lumen as unit.
16. Set Power field to 63.1lm.
17. Click Update.
18. Click Ok.
19. Click Save as.
20. Browse SPEOS input files folder of the project.
21. Rename as LE_UW_U1A5_01-6R-ebvF68_5M.RAY and click Ok.
22. Close the ray file editor.
23. Open ray-files rayfile_LEUW_U1A5_01_yellow_5M_061212_Speos.RAY.
24. Select Lumen as unit.
25. Set Power field to 1063.2lm.
26. Click Update.
27. Click Ok.
28. Click Add another ray file.
29. Browse file LE_UW_U1A5_01-6R-ebvF68_5M.RAY.
30. Click open.
   As far as file is quite heavy, the process can take time.
   At the end, a message appears.
31. Click Ok.
32. Click Mix all rays in the file.
33. Click Save as.
34. Browse SPEOS input files folder of the project.
35. Rename as LE_UW_U1A5_01-6R-ebvF68_5M.RAY and click Ok.
36. Click Ok.
37. Close the ray file editor.
   The ray-file you created defines the emitted light of LED LE_UW_U1A5_01-6R-ebvF68.

Lesson 4: Setting the Position and Orientation of the LED Source in your CAD

The LED source must be positioned and oriented in the CAD project.
1. Open LEUW_U1A5_01_061212_info.pdf from extracted folder.
2. Search Position and orientation of ray-file in CAD (page 1).
   For an OSRAM LED, the light starting point is on the coordinate system of the CAD part, and the orientation is the same as the CAD coordinate system.
   The X axis of source is also the CAD X axis.
3. Click Sketch 
4. Select Front Plane.
5. Click Line \.
6. Draw a line:
   1. with its starting point coincident with Origin,
   2. constraint as Horizontal,
   3. pointing toward X positive,
   4. Constraint length to 15mm with smart dimension tool.
7. Draw a second line:
   1. with its starting point coincident with Origin,
   2. constraint as Vertical,
   3. pointing toward Y positive
   4. Constraint its length equal to the first line drawn.
Your sketch must appear as displayed in the picture below.

8. Click Exit Sketch.
9. Select the Origin in the 3D View.
10. Right-click Sketch1 feature and select Feature Properties.
11. Rename it as RAYFILE_ref.
12. Click OK.
   - Your CAD product is ready to get the LED source.
13. Click Save.

**Lesson 5: Creating a Ray-file Source**

1. Click Ray file Source (Optical Properties).
2. In Source name, rename as 6R_ebvF68.
3. In Axis system, select 1 point - 2lines.
4. In Origin, click on the Origin in the graphics area.
5. In X Direction, click Line1@RAYFILE_ref line in the graphic area.
6. In Y Direction, click Line2@RAYFILE_ref line in the graphic area.
7. In Photometry, in Ray file name, browse LEUW_U1A5_01_5M.RAY file.
8. In Flux, select the From file option.
9. Click OK.
   - Now, your LED source is fully operational.
10. Click Save.

**Lesson 6: Creating an Interactive Simulation**

1. Click New, Assembly, and OK.
   - Your new assembly opens and begin assembly appears.
2. Click on your part open LEUW_U1A5_01.
3. Click on 3D View.
4. From FeatureManager design tree, right click on LEUW_U1A5_01 part.

5. Click Float.

6. Click Mate.

7. Select Point1@Origin and Point1@Origin@LEUW_U1A5_01.

8. Click OK.

9. From OptisWorks tree, click on LEUW_U1A5_01 source.

10. Click Ray Tracing Complete Update (Ray Tracing).
Running a Multi-Configuration Simulation

You must have the S_OW_LM2 solution and O_OW_OPTIM1 option.

To ease development and management of product variant or families, SolidWorks allows creation of configurations in same part. In the same way, OptisWorks can set a great number of simulations by setting a simulation per configuration and run them all in once.

1. Open the HIGH-MOUNT.SLDASM file.
   
   This file is located in OW_Tutorials_High_Mounted_Stop_2014_SP1.zip
   (../Common/OW_Tutorials_High_Mounted_Stop_2014_SP1.zip).

Setting the Configuration

1. In the ConfigurationManager tree, expand Tables folder node.
2. Right-click Design Table, and then select Edit Table.
   
   The Design Table assistant appears.
3. Click OK.
   
   Design table manager is now activated for edition.

   There are six configurations, driven by three parameters, the total system length (D3@PCB_ref), gap LED (D4@PCB_ref) and curvature of external lens (D3@LENS_Ext-Lens).

   Configurations are not set yet.
4. Set parameter values for each configuration, according to the following definition:

   Configuration | D3@PCB_ref | D4@PCB_ref | D3@LENS_Ext-Lens |
   --------------|------------|------------|------------------|
   HM_D150_G13_R5 | 150        | 13         | 5                |
   HM_D150_G13_R8 | 150        | 13         | 8                |
   HM_D150_G21_R5 | 150        | 21         | 5                |
   HM_D150_G21_R8 | 150        | 21         | 8                |
   HM_D200_G21_R5 | 200        | 21         | 5                |
   HM_D200_G21_R8 | 200        | 21         | 8                |
5. Click OK.
   
   Now configurations of your system are fully set.

Setting the Parameters of your Simulation

1. From OptisWorks tree, right-click on Direct simulation node.
2. Select Edit.
3. Under Number of emitted rays group box,
   
   1. type 1 in the box,
   2. select Mega-Rays from the list.
4. Click OK.
   
   Configuration manager of the Optis feature appears.
5. Select All configurations in list.
6. Click OK.

Running a Multi-Configuration Simulation

1. Click on Multi configuration simulation (Simulations).
2. In the Available simulations box, hold down Ctrl and select the six configurations with direct simulation:
### AVAILABLE SIMULATION TO SELECT

<table>
<thead>
<tr>
<th>Simulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>HM_D150_G13_R5/Direct</td>
</tr>
<tr>
<td>HM_D150_G13_R8/Direct</td>
</tr>
<tr>
<td>HM_D150_G21_R5/Direct</td>
</tr>
<tr>
<td>HM_D150_G21_R8/Direct</td>
</tr>
<tr>
<td>HM_D200_G21_R5/Direct</td>
</tr>
<tr>
<td>HM_D200_G21_R8/Direct</td>
</tr>
</tbody>
</table>

3. Click [ ] .

    Direct simulations of selected configurations are now available in Selected simulations box.

4. Click Run selected simulations.

### Opening the Results

1. Expand node from OptisWorks tree, situated under node Result Manager > Photometric results > Illuminance/Irradiance results > 2D maps.
   
   Each result is put in a folder with configuration name.

2. Expand each of result folders and double-click on illuminance map ILLUM_LENS-OUTPUT.xmp to open results.

3. Expand node from OptisWorks tree, situated under node Result Manager > Photometric results > Intensity results > 2D intensity.
   
   Each result is put in a folder with configuration name.

4. Expand each of result folders and double-click on illuminance map INT_OUTPUT.xmp to open results.

### Configuration | ILLUM_LENS-OUTPUT.xmp | INT_OUTPUT.xmp

<table>
<thead>
<tr>
<th>Configuration</th>
<th>ILLUM_LENS-OUTPUT.xmp</th>
<th>INT_OUTPUT.xmp</th>
</tr>
</thead>
<tbody>
<tr>
<td>HM_D150_G13_R5</td>
<td><img src="image1.png" alt="Graph" /></td>
<td><img src="image2.png" alt="Graph" /></td>
</tr>
<tr>
<td>HM_D150_G13_R8</td>
<td><img src="image3.png" alt="Graph" /></td>
<td><img src="image4.png" alt="Graph" /></td>
</tr>
</tbody>
</table>
HM_D150_G21_R5

HM_D150_G21_R8

HM_D200_G21_R5

HM_D200_G21_R8
Running an Optimization Routine with a Prism

You must have the LM2 package and the OPTIM2 option.

With this lesson, you are about to view how to run an optimization routine with OptisWorks' Optimization using a prism spectrometer. You are about to parameterize a photometric target, a mechanical variable and perform an optimization routine.

30 minutes

The optimizer finds the incidence of the input light beam to get the minimum deviation angle to find the refractive index of the prism glass material. Details about the refractive index measurement with a prism spectrometer can be found here (http://www.pa.msu.edu/courses/2002summer/PHY252/Prism.pdf).

1. Open the Optim_LM.SLDASM file.
   

2. In the OptisWorks tree, double-click Simulation.

3. Right-click Direct Simulation, and then select Edit.

   The PropertyManager appears.

4. Under Number of emitted rays, type 200 in the box and select Rays from the list.

5. Click OK ✅.
6. Right-click Direct Simulation, and then select Run or click Direct Simulation (Simulations). In the OptisWorks tree, a new map appears by double-clicking Result Manager, Photometric results, Intensity results, 2D intensity maps, DEFAULT.

7. Right-click the map, and then select Compute Targets.

8. Double-click the map to observe the measurements.
   Barycentre X and Y indicate the location of the spot on the map.
   We are going to use Barycentre X as a photometric target.

9. Drag Barycentre X to the Photometric targets folder, itself in the Optimization / tolerancing Targets folder, itself in the Optimization / tolerancing Parameters folder.
The PropertyManager appears.

10. In the PropertyManager, under Optimization / tolerancing parameters, set the Target value spinbox to 0.
11. Set the Defines the maximum value used in tolerancing spinbox to 0.
12. Set the Defines the minimum value used in tolerancing spinbox to 0.

You can check the XMP map parameters by clicking Target parameters. They must correspond to the parameters set in the detector definition.

13. Click OK.
14. In the FeatureManager design tree, double-click the sketch under Extrusion 1 of the prism part. All the constraints appear.

15. In the OptisWorks tree, double-click Optimization / tolerancing Parameters, Optimization / tolerancing Variables.
16. Right-click Mechanical variables, and then select Add Parameter.

The PropertyManager appears.
17. To select the 35 degrees angle dimension, click it in the graphics area.
If you cannot access the Variable definition PropertyManager, you can see Known Problem.

18. Right-click the parameter D4, and then select Edit.
   The PropertyManager appears.

19. Under Optimization / tolerancing Parameters, type 35 in the Min value box and 65 in the Max value box.

20. Click OK ✔.

21. Right-click Optimization in Optimization / tolerancing Parameters, itself in the OptisWorks tree, and then select Edit.
   The PropertyManager appears.

   There are three different methods to run the optimization process:
   The Evolutionary engine option (Evolutionary engine: ON, Gradient engine: OFF), when you select only the Evolutionary engine check box, corresponds to a conventional genetic engine.
   The Gradient engine option (Evolutionary engine: OFF, Gradient engine: ON), when you select only the Gradient engine check box, must be used when the system is very close to the best solution. The engine will look around the starting value using 1/100 steps until it reaches a better solution.
   The combination of the Evolutionary engine and Gradient engine options (Evolutionary engine: ON, Gradient engine: ON), when you select both the Evolutionary engine check box and the Gradient engine check box, starts with the first algorithm until a fine solution is found. Then the gradient engine is used to refine the solution.
   The Time without improvement (mn) box defines the time that the process lasts to find a temporary best solution.
   It is possible to choose between an optimizing direct simulation and an optimizing inverse simulation.
   Finally, the merit function can be minimized or maximized.
   You can choose to use the default merit function or can define your own merit function.

22. For the tutorial, select only the Evolutionary engine check box.

23. For the tutorial, click Uses the Direct simulation.

24. For the tutorial, click Minimize Merit function and Default.
More details available here (see page 117).

25. To launch the process, right-click Optimization, and then select Run or click Optimization (Simulations).

At the end of the optimization routine, the software asks you in a box if you want to replace the value of the variable with the most suitable one corresponding to the best solution.

Finally, the optimization report appears by double-clicking Result Manager, Optimization / tolerancing results, Optimization.

Merit function: default
Barycentre X = 0.000e+000 rad (weight = 1)
Minimize merit function

Optimization using direct simulation

<table>
<thead>
<tr>
<th>D4</th>
<th>Merit</th>
<th>Barycentre X</th>
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</thead>
<tbody>
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</tr>
</tbody>
</table>

Status: 65
Best Solution
D4 = 49.304
Merit function = 0.679369
Barycentre X = 0.679369

Using the following formula with alpha equals to 60 degrees (prism angle) and beta the best solution, the refractive index is equal to 1.5199, which corresponds to the prism refractive index of 1.52.

\[
\frac{\sin\left(\frac{\alpha + \beta}{2}\right)}{\sin\left(\frac{\alpha}{2}\right)}
\]
Running an Optimization Routine

You must have the LM2 package, the COL and the OPTIM2 options.

With this lesson, you are going to view how to run an optimization routine using OptisWorks' Optimization. You are going to optimize the power of three colored light sources (Red, Green, Blue) to obtain a perfect white color (x=0.33, y=0.33) from the mix of the three light sources.

30 minutes

1. Click Virtual Photometric Lab (Labs).
   A box appears.

2. In the box, click .
   Another box appears.

3. In the box, in the Colorimetry tab, check that xyY is selected from the Default colorimetric system list.

4. Save the configuration, and then close the viewer.

5. Exit OptisWorks.

6. Open the Optim_COL.SLDASM file.

7. To launch a ray tracing, click Ray Tracing Complete Update (Ray Tracing).

8. In the OptisWorks tree, double-click Simulation.

9. Right-click Direct Simulation, and then select Edit.
   The PropertyManager appears.
   Under Number of emitted rays, type 100 and select Kilo-rays from the list.

10. Click OK.

11. Right-click Direct Simulation, and then select Run or click Direct Simulation (Simulations).
In the OptisWorks tree, by clicking Result manager, Photometric results, Illuminance/Irradiance results, 2D maps, Default, you can see a new map.

12. Right-click the map, and then select Compute targets.

13. Double-click the map to observe the measurements.

   Color 1, 2 and 3 indicate the average color of the map.
   Color 1 corresponds to x, Color 2 to y and Color 3 to Y.
   We are going to use Color 1 and 2 to define the color target.

14. Drag Color 1 to the Photometric targets in Optimization / tolerancing Targets, itself in Optimization / tolerancing Parameters.

   The PropertyManager appears.

15. Under Optimization / tolerancing parameters, set the value of the Target value spinbox, to 0.33.

16. In the Defines the maximum value used in tolerancing box and in the Defines the minimum value used in tolerancing box, type 0.33 or use the arrows to set the value at 0.33.

17. Repeat the same action for the Color 2 file.

18. In the OptisWorks tree, in Optim_COL (Default), double-click Sources, Photometric sources, and then double-click the first source.

19. Drag the power of the source to the Optical Variables folder in Optimization / tolerancing Variables, itself in Optimization / tolerancing Parameters.

20. Right-click the power, and then select Edit Parameter.

   The PropertyManager appears.

21. Type 1 in the Min value box and 1000 in the Max value box.

22. Click OK ✓.

23. Repeat the complete actions for the second and the third source.

24. Right-click Optimization in Optimization / tolerancing Parameters, itself in the OptisWorks tree, and then select Edit.

   The PropertyManager appears.

There are three different methods to run the optimization process:

   The Evolutionary engine option (Evolutionary engine: ON, Gradient engine: OFF), when you select only the Evolutionary engine check box, corresponds to a conventional genetic engine.

   The Gradient engine option (Evolutionary engine: OFF, Gradient engine: ON), when you select only the Gradient engine check box, must be used when the system is very close to the best solution. The engine will look around the starting value using 1/100 steps until it reaches a better solution.

   The combination of the Evolutionary engine and Gradient engine options (Evolutionary engine: ON, Gradient
engine: ON), when you select both the Evolutionary engine check box and the Gradient engine check box, starts with the first algorithm until a fine solution is found. Then the gradient engine is used to refine the solution.

The Time without improvement (mn) box defines the time that the process lasts after a temporary best solution is found.

It is possible to choose between an optimizing direct simulation and an optimizing inverse simulation.

Finally, the merit function can be minimized or maximized. You can choose to use the default merit function or can define his own merit function.

25. For the tutorial, select only the Evolutionary engine check box.

26. For the tutorial, click Uses the Direct simulation.

27. For the tutorial, click Minimize Merit function and Default.

More details available here (see page 117).

28. To launch the process, right-click Optimization, and then select Run or click Optimization (Simulations).

At the end of the optimization routine, the software asks you in a box if you want to replace the value of the variable with the most suitable one corresponding to the best solution.

The optimization report appears by double-clicking Result Manager, Optimization / tolerancing results, Optimization.

Optimization report:

Merit function:
Color 1 - 0.33
Color 2 - 0.33

<table>
<thead>
<tr>
<th>Power</th>
<th>Power</th>
<th>Power</th>
<th>Target</th>
<th>Color 1</th>
<th>Color 2</th>
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<td>410.261</td>
<td>140.848</td>
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<tr>
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<td>295.191</td>
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<td>385.707</td>
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<td>0.092802</td>
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<tr>
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<td>838.191</td>
<td>0.173845</td>
<td>0.272654</td>
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<td>951.48</td>
<td>0.037682</td>
<td>0.338599</td>
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</tr>
</tbody>
</table>
29. Run a direct simulation, and then check the results.

Creating a Tolerancing on LED Collimator

You must have S_OWX_LM2 solution with the O_OWX_OPTIM1 option.

30 minutes of preparation + 10 minutes for tolerancing

With this tutorial, you are going to learn how to manage tolerancing on a basic project.

Lesson 1: Preparing Data
2. Extract files.
3. Open assembly CPC_Assembly.SLDASM.

Lesson 2: Setting and Running a Direct Simulation

Linking Measurement to a Sensor’s Result
1. Right-click INT sensor under the node Detectors, Intensity detectors, 2D intensity maps.
2. Select Edit.
3. In the Parameters group box, select Associates a measure template to XMP.
4. Click Browse.
5. In the Input folder, select CPC_INT-check.xml.
6. Click Open.
7. Measurements are associated to the sensor’s result.
8. Right-click IRRA sensors under the Detectors, Illuminance / Irradiance detectors, 2D maps node.
10. In the Parameters group box, select Associates a measure template to XMP.
11. Click Browse.
12. In the Input folder, select CPC_IRRA-check.xml.
13. Click Open.
14. Measurements are associated to the sensor’s result.
15. Click Ok ✔️.
Setting the Direct Simulation Parameters

1. Right-click the Direct simulation node in the OptisWorks tree and select Edit.
2. In the Number of emitted rays box, type 1 and select Mega-rays.
3. Click Ok ✔.
   The direct simulation is configured.
4. Click Direct Simulation (Simulations).
   The simulation takes roughly one minute on a desktop computer.

Opening Intensity Results

1. Double-click the INT.xmp file to open the result under the node Result Manager, Photometric results, Intensity results, 2D maps, DEFAULT, INT.
2. Click Tools, Level.
3. Set Value to 100.
4. Click Tools, Measures.
   Flux and Barycentre_theta are measured in the TARGET area. These measurements in the define area are used for the tolerancing.
5. Close the Virtual Photometric Lab windows.

Opening Illuminance Results

1. Double-click the IRRA.xmp file to open the result under the node Result Manager, Photometric results, Illuminance/Irradiance results, 2D maps, DEFAULT, IRRA.
2. Double-click the CPC_ASSYM.Direct simulation.1.IRRA.xmp file to open the result.
3. Click Tools, Level.
4. Set Value to 200.
5. Click Tools, Measures.
Sigma is evaluated in the area A_TARGET. These measurements are used for the tolerancing.

6. Close the Virtual Photometric Lab windows.

**Lesson 3: Setting a Tolerancing**

**Defining Dimensions as Variables**

1. In the FeatureManager design tree, double-click the Def_Top Lens sketch of LENS_lens part.
   The dimensions constraining the sketch appear.

2. In the OptisWorks tree, expand the node Optimization / tolerancing Parameters, Optimization / tolerancing Variables.

3. Right-click on Mechanical variables and select Add Parameter.
   The PropertyManager appears.

4. From the 3D View, select dimension D1@Def_Top Lens, defining the width of the top lens.

   If you cannot access the Variable definition PropertyManager, check the Known Problems.

5. Click OK.

6. From Mechanical variables, right-click D1 parameter and select Edit Parameter.
   The PropertyManager appears.

7. Set Min value to 0.8, Max value to 1.2 and Step number to 7.

8. Select the Quasi-Monte Carlo type.
   Variable values are generated according to a quasi-Monte Carlo density distribution.

9. Click OK.
10. In the FeatureManager design tree, double-click Sketch39 within the Revolve6 of LENS_lens part. The dimensions constraining the sketch appear.

11. From the OptisWorks tree, right-click Mechanical variables and select Add Parameter. The PropertyManager appears.

12. From the 3D View, select the D2@Sketch39 dimension, defining the fillet on top of teeth-lens.

13. Click OK.

14. From Mechanical variables, right-click the parameter D2 and select Edit Parameter. The PropertyManager appears.

15. Set Min value to 0.05, Max value to .1, Step number to 7.

16. Select Gaussian type.

With this option you generate random values of the variable, according to a gaussian density distribution centered on the nominal value, and a spread characterized by the FWHM.

17. Set Nominal value to 0.08 and FWHM to .03.

18. Click OK.

Variables for optimization are set.

Setting the Tolerancing Targets

1. Right-click INT results, and select Compute Targets.

For more information about checking results localization in the OptisWorks tree, you can view Lesson 2: Setting and Running a Direct Simulation (see page 166).

2. Expand the node INT, to display the measurements.

3. Right-click on Barycentre X measurement under INT result and select Define as Optimization / Tolerancing target(s).

Barycentre X corresponds to the angular position from zenith of the spot. The PropertyManager appears.

4. Rename the target TARGET_theta-pos.

5. Set Min value to 0.349 and Max value to 0.415.

6. Click Target parameters.

7. Set the target area according to the following parameters:

<table>
<thead>
<tr>
<th>Theta Min</th>
<th>Theta Max</th>
<th>Phi Min</th>
<th>Phi Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>55</td>
<td>330</td>
<td>30</td>
</tr>
</tbody>
</table>

8. Click Ok.

9. Click OK.
10. Right-click Flux measurement under INT result and select Define as Optimization / Tolerancing target(s).
   The PropertyManager appears.
11. Rename the target as TARGET_flux.
12. Set Min value to 71 and Max value to 85.
13. Click Target parameters.
14. Set the target area according to the following parameters:

<table>
<thead>
<tr>
<th>Theta Min</th>
<th>Theta Max</th>
<th>Phi Min</th>
<th>Phi Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>55</td>
<td>330</td>
<td>30</td>
</tr>
</tbody>
</table>

15. Click Ok.
16. Click OK ✓.
17. Right-click IRRA results and select Compute Targets.
18. Expand the IRRA node to display the measurements.
19. Right-click Sigma and select Define as Optimization / Tolerancing target(s).
   The PropertyManager appears.
20. Rename the target as TARGET_sigma.
21. Set Min value to 0 and Max value to 300.
22. Click Target parameters.
23. Set the target area according to the following parameters:

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
<th>Width</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-50</td>
<td>300</td>
<td>1000</td>
</tr>
</tbody>
</table>

24. Click Ok.
25. Click OK ✓.

**Setting Tolerancing Parameters**

1. Right-click the Tolerancing node under Optimization / tolerancing parameters in OptisWorks tree.
2. Click Edit.
3. Select Keep intermediate result.
4. Click Ok ✓.
   The tolerancing is ready to be launched.

**Lesson 4: Running the Tolerancing**

1. Click Tolerancing (Simulation).
   The tolerancing report appears under the Tolerancing of Tolerancing / Optimization results node.
2. From your explorer, open the Output folder of the project.
   Tolerancing report is automatically generated in .txt and .csv format.
3. Open Default_(Current) Tolerancing.txt
   The tolerancing report reminds the first variables and the parameters configuration and then gives the target values for each tested combination.
Including a 3D Texture in an Optical System

You must have the LM2 package with the 3DTEXT option.

1 hour

Lesson 1: Creating a Pattern

1. Open OptisWorks.
2. Click New.
3. Select Part.
   Click OK.
4. Save the part as Sphere.SLDPRT by clicking File, Save As...
5. In the FeatureManager design tree, select Front Plane, and then click Sketch to create a new sketch.
6. Draw a line along the Y direction, coincident with the Y axis.
7. Make the origin of the part the center of the line, and then set the length of the line to 0.1mm with the Smart Dimension tool.
8. Draw a centerpoint arc with the line's midpoint as center, one line's boundary as starting point and the other as ending point.
9. Validate the sketch.

10. Select the sketch.

11. Click Features, Revolved Boss/Base.

   The PropertyManager appears.

12. Choose the line as the axis of Revolution by clicking it in the graphics area.

13. If it is selected, click to clear the Thin Feature check box.

14. Select the contours of the sketch by clicking it in the graphics area.

15. Click OK ✓.

16. Click the OptisWorks menu, Additional Features, Pattern Definition Export..., and then save the text file as Sphere.txt.

   OptisWorks creates a text file containing all the information related to the geometry defined in the part.
Lesson 2: Creating a Mapping

You can use a text editor or any software with worksheets when the map includes a lot of patterns. We illustrate the way to proceed with Microsoft Excel.

1. Open Microsoft Excel.
2. In the top left cell, type 50.
   This is the number of patterns you are going to represent in the texture.
3. In the second line, type the following sequence with one digit per cell from left to right: 0 0 0 1 0 0 0 1 0 1 1 1.

   The first three digits correspond to the coordinate of the pattern's origin with the respect of the texture coordinate system.
   The second three digits correspond to the orientation of the pattern with the respect of the X direction of the texture coordinate system.
   Here, the X direction of the both pattern and texture coordinate systems are the same.
   The third three digits correspond to the orientation of the pattern with the respect of the Y direction of the texture coordinate system.
   Here, the Y direction of the both pattern and texture coordinate systems are the same.
   The three last digits represent the pattern scale values for respectively X, Y and Z directions, 1 meaning 100% of the original pattern size.
4. Duplicate this line of values.
5. Add a formula in the first cell of the third line to increment the x coordinate with 0.2.
6. Add a formula to the second cell of the line to keep the y coordinate constant.
7. Duplicate the line three times.

8. Select the lines 2 to 6, copy those, and then paste those behind.

9. Add a formula to the second cell of the line 7 to increment the y coordinate with 0.2.

10. Select the lines 7 to 11, copy them, and then paste them eight times to finish the map.
11. Save the mapping as Map.txt.

   You must save the file to Text (MS-DOS) or Text (Tab-delimited) text formats.

**Lesson 3: Creating the Light Guide**

1. Click New.
2. Select Part.
3. Click OK.
4. Save the part as LightGuide.SLDPRT.
5. In the FeatureManager design tree, select Front Plane, and then click Sketch to create a new sketch.
6. Create a corner rectangle.
7. With the Smart Dimension tool, set the rectangle length to 2mm along the Y direction and the width to 1mm along the X direction.
8. Use the Smart Dimension tool to position the bottom left corner at 0.1mm from the origin along the X and Y directions.

9. Draw a point at the exact location of the origin of the part.

10. Validate the sketch, and then choose to show it.

11. Select the sketch, and then click Features, Extruded Boss/Base.

12. Make an extrusion of 0.5mm with the respect of the Z direction.

13. Validate the extrusion, and then save the part.

**Lesson 4: Creating the 3D Texture**

1. Click New.
2. Select Assembly.
3. Click OK.
4. Insert the LightGuide.SLDPRT part by clicking Insert, Component, Existing Part/Assembly.

5. Save the assembly as Backlight.SLDASM.

6. Click 3D texture (Additional Features).
   The PropertyManager appears.

7. Type Spheres in the 3D texture name box.

8. In the Apply on surfaces box, to select the face where the part's sketch is drawn to apply the texture on it, click it in the graphics area.

9. Under Axis system definition, in the Origin box, to select the point of the part's sketch to define the origin of the axis system, click it in the graphics area.

10. To define the X and Y directions in the Direction of the X axis box and in the Direction of the Y axis box, click two edges in the graphics area.
11. Make sure they are orientated in the same way as the X and Y axes of the assembly.

12. Under Pattern definition, browse the Sphere.txt file in the Pattern definition box, and then browse the Map.txt file in the Mapping definition box.
   - Under Optical Properties, in the Pattern surface quality box, Optical_Polished.opt is set by default.

13. Under Parameters, select Remove from the Parameters list.
   - You can then preview an amount of patterns by clicking Preview.

14. Click OK.

Lesson 5: Creating a Light Source

1. Click New.
2. Select Part.
3. Click OK.
4. Save the part as Source.SLDPRT.
5. In the FeatureManager design tree, select Top Plane.
6. Click Sketch to create a new sketch.
7. Create a corner rectangle.
8. With the Smart Dimension tool, set the rectangle length to 1mm along the X direction and the width to 0.5mm along the Z direction.

9. Draw a centerline from one corner of the rectangle to the other.

10. Place a point in the middle of the centerline.

11. Use this point to sketch an ellipse.

12. Validate the sketch.
13. Click Features, Extruded Boss/Base.
14. Set a Blind extrusion of 0.2mm.
15. Reverse its direction, and then apply to the outer square as below in the Selected Contours box.

16. Click Features, Extruded Boss/Base.
17. Do the extrusion for the ellipse by selecting it in the Selected Contours box.

18. Click Surface Source (Optical Properties).
19. Select the ellipse as the emissive face.
20. Define the source as follows.

21. Click OK, and then save.

**Lesson 6: Running an Interactive Simulation**

With this lesson, you learn how to insert the light source into the project, to set and launch an interactive simulation.

1. Go back to Backlight.SLDASM.
2. Click Insert, Component, Existing Part/Assembly...
   The PropertyManager appears.
3. Double-click the Source part.
4. Drop it in the graphics area.
5. Select the emitting surface of the source by clicking it in the graphics area, and then click Assembly, Mate. The PropertyManager appears.
6. Select the input face of the light guide by clicking it in the graphics area.
7. Set a distance between the two faces of 0.001mm by clicking Distance in the PropertyManager, under Standard Mates, and set the value of the spinbox. You must be careful about the distance orientation.
8. Click OK.

9. Click Assembly, Mate.
10. Select the top face of each part, the Source and the Light guide part.
11. Click Coincident.
12. Click OK.
13. Click Assembly, Mate.
14. Select the right face of each part, the Source and the Light guide part.
15. Click Coincident.
16. Click OK.

17. In the OptisWorks tree, double-click Simulations, Interactive simulation to check the interactive simulation settings.
18. Click Ray tracing Complete Update (Ray Tracing) to launch an interactive simulation.

You can visualize the ray tracing with the 3D texture by clicking Tessellation Display (3D View).

We can observe that all the rays are not extracted by the 3D textures.

19. To block the light leakage from back and sides of the Light guide and the Source, click the OptisWorks menu, New Optical Properties Definition, Surface, Simple Scattering Surface Quality...

A box appears.

20. In the OptisWorks - Scattering surface box, type 100 in the Absorption box.

21. Save the scattering file as 100_absorption.simplescattering by clicking File, Save As... in the box.

22. In the OptisWorks - Scattering surface box, type 0 in the Absorption box.

23. If needed, click to clear the Transmission check box.

24. Select the Reflection check box, and then type 0 in the available Lambertian and Gaussian boxes.

25. Save the scattering file as 100_specular_reflection.simplescattering by clicking File, Save As... in the box.


27. Open LightGuide.SLDPRT.
28. To select the following face, click it in the graphics area.

29. Click Surface Quality (Optical Properties).

   The PropertyManager appears.

30. In the Surface quality box, browse the 100_absorption.simplescattering file.

31. Click OK.

32. Repeat these actions with the two following side faces and with the 100_specular_reflection.simplescattering file for the surface quality.

33. Save, and then close the part.

34. Open Source.SLDPRT.

35. Click Part Preferences (Optical Properties).

   The PropertyManager appears.

36. Browse the 100_specular_reflection.simplescattering file for the surface quality.

37. Click OK.

38. Save, and then close the part.
39. Update the assembly and run an interactive simulation.

Lesson 7: Defining Detectors

1. Click the following surface.

2. To create a new plane, click Insert, Reference Geometry, Plane...
The plane is located at 0.1mm from the selected face.

3. Select the new plane and create a sketch.
4. With the Center line tool, draw two axes from the middle point.
5. Exit from the sketch, and then save your file.
6. Click Illuminance Detector (Detectors).
7. Set the parameters as follows.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VALUE</th>
</tr>
</thead>
</table>


8. Click Intensity Detector (Detectors).

9. Set the parameters as follows.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detector name</td>
<td>Intensity detector 1</td>
</tr>
</tbody>
</table>
| Detector definition| Point1@Sketch1 for Center of the map  
|                    | Point3@Sketch1 for Direction of the X axis (point)  
|                    | Point4@Sketch1 for Direction of the Y axis (point) |
| Type of detector   | Photometric detector |
| Type of intensity detector | Conoscopic |
| Map Size           | Theta Max = 90.00deg |
| Sampling           | X = 200  
|                    | Y = 200  |
Lesson 8: Launching Simulations

1. In the OptisWorks tree, to set the parameters of the simulation and the parameters of the direct simulation as follows, do the following:

   1. Right-click Simulation parameters, and then select Edit.
   2. Set the parameters.
   3. Click OK.
   4. Repeat the same actions for Direct simulation.

2. Right-click Direct Simulation, and then select Run or click Direct simulation (Simulations).
3. In the OptisWorks tree, double-click Result Manager.
4. Open the different folders to find the illuminance and intensity results.
5. Double-click them.
Analyzing an Optical System by Using the Stray Light Analysis

You must have the LM2 package and the LXP, COL and SLA options.

With this tutorial, you are about to set an optical system to get a list of optical sequences and to analyze them to get the signal to noise ration result.

1 hour 30 minutes

Lesson 1: Defining Sequences

1. Open the StrayLightAnalysis.SLDASM file.
   This file is located in OW_Tutorials_Stray_Light_Analysis.zip (http://portal.optis-world.com/documentation/UG/OW/ZIP/OW_Tutorials_Stray_Light_Analysis.zip).

2. In the OptisWorks tree, double-click Sources, Photometric sources.
3. Check that XMP source is unsuppress.
4. Double-click Detectors, Illuminance/Irradiance detectors, 2D Maps.
5. Edit the Zoom<1>zoom_plan5<1> file.
6. Under Parameters, select the Generates LPF file check box.
7. Click OK ✓.
8. Save the changes made to Zoom.SLDASM.
9. Go back in the assembly.
10. In the OptisWorks tree, double-click Simulations.

   11. Right-click Direct Simulation, and then select Run or click Direct simulation (Simulations).

       In the OptisWorks tree, a new map appears by double-clicking Result Manager, Photometric results, Illuminance/Irradiance results, 2D maps.

12. Right-click the map, and then select Display result to open it or directly double-click it.

13. Click Virtual Photometric Lab (Labs).

    A box appears.
14. Click Tools, Sequence Detection... to open the Sequence Detection box.

![Sequence Detection box](image1)

15. In the Sequence detection box, type 1000 in the Max rays to parse box.

16. Click Parse to launch the sequence detection.

![Sequence detection progress](image2)
17. Once the ten sequences are detected, the lists of interactions and sequences are filled.

In the list of interactions:
The items in the Object column are always -1 in OptisWorks.
The items in the Face column are references to faces of the system geometry.
The items in the Interaction column correspond to the type of interaction on the face.

In the list of sequences:
The items in the Sequence column present the sequence of interactions to reach the detector.
The items in the Length column correspond to the number of interactions.
The items in the No. hits column correspond to the number of rays that followed the sequence.
The item in the Energy(%) column shows the corresponding energy percentage of the sequence over the list.
With the Selected column, you can select the sequence for an analysis by clicking the corresponding row.

18. Click Select all to select the entire sequence list, and then save the sequence that is useful to analyze the system.

Lesson 2: Analyzing Sequences

1. In StrayLightAnalysis.SLDASM, right-click Zoom<1>Zoom_Plan5<1>, and then select Edit.
   The PropertyManager appears.

2. Under Parameters, click to clear the Generates LPF file box, and then select the Data separated by layer check box.

3. Click By sequence.

4. Click OK.

5. Save the changes made to Zoom.SLDASM, and then close it.


7. Right-click Sequence definition and select Edit. And Check if Sequence definition is active, if not right-click and select Unsuppress.
   The PropertyManager appears.

8. In the Sequence definition box, browse the sequence file previously generated.

9. Click Keep.
10. Click OK.
11. In the OptisWorks tree, double-click Simulations.
12. Right-click Direct Simulation, and then select Run or click Direct simulation (Simulations).
13. In the OptisWorks tree, double-click Result Manager, Photometric results, Illuminance/Irradiance results, 2D maps, DEFAULT.

A new map appears.
14. Right-click it, and then select Display result to open it or directly double-click it.

You can display the illuminance results sequence by sequence by selecting them from the list.

15. For example, display the results of Sequence 1 which is the map with the highest number of hits.
The bright spot at the center of the map is not obtained by this specific sequence.

16. For example, change the sequence to All other sequences. The bright spot that we are looking for appears.

17. This layer corresponds to all the other sequences that have not been parsed during the sequence detection.
18. Close the box.
19. Go back to Zoom<1>Zoom_Plan5<1> detector’s definition.
20. Select the Generates LPF file check box, and then click OK.
21. Save the changes made to Zoom.SLDASM, and then close it.
22. Click Direct simulation (Simulations).
23. In the OptisWorks tree, double-click Light Expert, Light Path Finder, Results, DEFAULT.
   A new map appears.

24. Right-click it, and then select Display result to open it or directly double-click it.

25. In the Virtual Photometric Lab, click Measures to launch the interactive ray tracing.

26. Expand the rectangle selection to the entire map surface.
27. Open Sequence 7 and observe the ray tracing update.
To visualize the interactive ray tracing of the All other sequences layer, you must suppress the sequence definition by right-clicking Sequence definition, and then by selecting Suppress.
Lesson 3: Viewing the Signal to Noise Ratio

1. In the OptisWorks tree, double-click Result manager, Photometric results, Illuminance/Irradiance results, 2D maps, DEFAULT.
2. Open the last map of the list.
3. In Virtual Photometric Lab, edit the Virtual Lighting Controller.
4. Click to clear all the optical sequences except the first one.

5. Click File, Export to save the map as Signal.xmp.
6. If it is not done, click the Merge active layer(s) check box in the Export parameters box, and then click OK.
7. Edit the Virtual Lighting Controller and select all the optical sequences except the first one.

8. Click File, Export to save the map as Noise.xmp.
9. If it is not done, select the Merge active layer(s) check box, and then click OK.
10. Open Photometric Calc.
11. Select Signal.xmp and Noise.xmp as source files.
12. Select Signal to noise ratio from the Operation list.
13. Save the result as SignalToNoise.xmp.
14. Click Process, and then open the result.
15. Remove the filtering.
16. Change the maximum scale value to 5 to visualize a clearer signal to noise ratio result.

Creating and Analyzing a LED Package

You must have the LM2 package, and the FLUO and COL options.

This tutorial aims at using basic features in OptisWorks to create and analyze a LED package.
In this exercise, you will go through the lessons of a basic OptisWorks project.

**Lesson 1: Creating a LED Geometry**

This page shows how to create a LED geometry including the body, the chip and the cavity.

1. Open OptisWorks.
2. Click New.
3. Select Part in the box which appears, and then click OK.
4. In the FeatureManager design tree, right-click Front Plane, and then select Sketch.
   The Sketch mode is activated.
5. If needed, select the Front view.

6. Click the arrow, next the Line tool, and then click Centerline.
7. Draw the construction line as follows.

8. Select the origin of the sketch and the center line to add a Midpoint relation between the two entities.
9. Click Line \( \backslash \), and then sketch lines as follows.
10. Select all the sketch elements, and then click Mirror Entities to get the following result.

11. Validate the sketch, and then save the part as Body.sldprt.

12. Save as the part again, but this time selecting the Save as copy check box and typing Cavity in the File name box.

13. Repeat this operation by naming the part Chip.

14. Select the sketch, and then click Extruded Boss/Base.

   The PropertyManager appears.

15. Under Direction 1, select Mid Plane from the list, and then type 8 in the Distance box.
16. Select the sketch contour as follows, and then validate the extrusion.

17. Open Cavity.sldprt.

18. Select the sketch, and then click Revolved Boss/Base.
   The PropertyManager appears.
19. Set the revolution axis using the center line of the sketch, and then select the contours as follows.

![Revolve Parameters](image)

- **Revolve Parameters**
  - `line1 @ Sketch1`
  - `One-Direction`
  - `360.00deg`

- **Selected Contours**
  - `Sketch1-Region<1>`

20. Validate the construction.

![Model](image)


22. Select the sketch, and then click Extruded Boss/Base.

23. Under Direction 1, select Mid Plane from the list, and then type 2 in the Distance box.
24. Select the following contours:

25. Validate the construction.

26. Click New

27. Select Assembly, and then click OK.

28. Click Insert, Component, Existing Part/Assembly.
   The PropertyManager appears.

29. Select Body.

30. Save the assembly as GS_LED_packaging.sldasm.

31. Click Insert, Component, Existing Part/Assembly.
   The PropertyManager appears.

32. Select Cavity.

33. Repeat this operation selecting Chip.
   The tree parts are now in the assembly.
34. Select the Body part, and then click Edit Component.

35. Click Insert, Features, Cavity.

36. In the Design Components section, select the Cavity and Chip parts.

37. Validate the operation, and then click Edit Component to go back to the assembly mode.

When opening the Body part, we observe that the geometries of the Cavity and Chip parts have been removed from the extrusion.

38. Repeat the previous steps with the Cavity part and removing this time the Chip part.
When opening the Cavity part, the geometry of the Chip part has been removed.

You can choose to tune the color of each part by right-clicking it, and then by selecting Appearances. You can change the color in the same way as the optical properties.

Lesson 2: Creating a Phosphor Material

1. Click Material Definition (Editors).
   A box appears.

2. In the General tab, select Fluorescent from the Material Type list.

3. A new Fluorescence tab appears in the editor.

4. In the Index variation tab, select Define dispersion curve by index and constringence from the list.

5. Type 1.4 in the Index at 587nm box and 100 in the Constringence box.

6. In the Absorption variation tab, set the absorption coefficients using the following data.
   You can click \( \text{+} \) to insert cells.

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Absorption coefficient (mm(^{-1}))</th>
<th>Wavelength (nm)</th>
<th>Absorption coefficient (mm(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>486</td>
<td>0.01</td>
<td>583.7</td>
<td>0.0636</td>
</tr>
<tr>
<td>487.9</td>
<td>0.0186</td>
<td>589.6</td>
<td>0.0645</td>
</tr>
<tr>
<td>490.4</td>
<td>0.0244</td>
<td>594.6</td>
<td>0.062811</td>
</tr>
</tbody>
</table>
### Optical Properties

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Absorption coefficient (mm⁻¹)</th>
<th>Wavelength (nm)</th>
<th>Absorption coefficient (mm⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>493.2</td>
<td>0.0269</td>
<td>597.7</td>
<td>0.0529</td>
</tr>
<tr>
<td>495.7</td>
<td>0.0266</td>
<td>598.4</td>
<td>0.0493</td>
</tr>
<tr>
<td>498.2</td>
<td>0.0255</td>
<td>602.4</td>
<td>0.0476</td>
</tr>
<tr>
<td>502.2</td>
<td>0.0266</td>
<td>604.9</td>
<td>0.0498</td>
</tr>
<tr>
<td>506.6</td>
<td>0.0285</td>
<td>605.9</td>
<td>0.0539</td>
</tr>
<tr>
<td>507.2</td>
<td>0.0307</td>
<td>607.4</td>
<td>0.0578</td>
</tr>
<tr>
<td>514.4</td>
<td>0.0343</td>
<td>608.7</td>
<td>0.0672</td>
</tr>
<tr>
<td>516</td>
<td>0.0371</td>
<td>611.5</td>
<td>0.0683</td>
</tr>
<tr>
<td>532</td>
<td>0.05</td>
<td>614.3</td>
<td>0.0675</td>
</tr>
<tr>
<td>538.7</td>
<td>0.05</td>
<td>617.1</td>
<td>0.065</td>
</tr>
<tr>
<td>541.9</td>
<td>0.0479</td>
<td>622.7</td>
<td>0.0623</td>
</tr>
<tr>
<td>546.6</td>
<td>0.0479</td>
<td>628</td>
<td>0.0625</td>
</tr>
<tr>
<td>553.7</td>
<td>0.0576</td>
<td>631.5</td>
<td>0.0639</td>
</tr>
<tr>
<td>562.2</td>
<td>0.0578</td>
<td>637.4</td>
<td>0.0661</td>
</tr>
<tr>
<td>567.2</td>
<td>0.0551</td>
<td>639.6</td>
<td>0.0689</td>
</tr>
<tr>
<td>576.2</td>
<td>0.0573</td>
<td>643</td>
<td>0.07</td>
</tr>
</tbody>
</table>

The absorption variation must look as follows.

7. In the Fluorescence tab, click to add a dye.
   The Dye box appears.
9. Type Green phosphor pigment in the Description box.

10. In the Spectrum tab, click Absorption spectrum.

11. Click  

12. The Spectrum box appears.

13. Enter the following data.

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Absorption coefficient (mm-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>360</td>
<td>11.69</td>
</tr>
<tr>
<td>380</td>
<td>12.49</td>
</tr>
<tr>
<td>400</td>
<td>12.59</td>
</tr>
<tr>
<td>420</td>
<td>12.65</td>
</tr>
<tr>
<td>440</td>
<td>12.64</td>
</tr>
<tr>
<td>450</td>
<td>12.41</td>
</tr>
<tr>
<td>460</td>
<td>11.87</td>
</tr>
<tr>
<td>470</td>
<td>10.66</td>
</tr>
<tr>
<td>480</td>
<td>8.63</td>
</tr>
<tr>
<td>490</td>
<td>6.04</td>
</tr>
<tr>
<td>499</td>
<td>3.72</td>
</tr>
<tr>
<td>510</td>
<td>0</td>
</tr>
</tbody>
</table>

14. Name the spectrum Green Phosphor Absorption.

15. Repeat this operation for the Efficiency spectrum with the following data.

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Value (%)</th>
<th>Wavelength (nm)</th>
<th>Value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>430</td>
<td>0</td>
<td>570</td>
<td>6.5</td>
</tr>
<tr>
<td>440</td>
<td>0</td>
<td>580</td>
<td>5.7</td>
</tr>
<tr>
<td>450</td>
<td>0.8</td>
<td>590</td>
<td>4.5</td>
</tr>
<tr>
<td>460</td>
<td>1</td>
<td>600</td>
<td>3.7</td>
</tr>
<tr>
<td>470</td>
<td>1.9</td>
<td>610</td>
<td>2.7</td>
</tr>
<tr>
<td>480</td>
<td>3</td>
<td>620</td>
<td>2.2</td>
</tr>
<tr>
<td>490</td>
<td>4.5</td>
<td>630</td>
<td>1.6</td>
</tr>
<tr>
<td>500</td>
<td>6</td>
<td>640</td>
<td>1.5</td>
</tr>
<tr>
<td>510</td>
<td>8</td>
<td>650</td>
<td>1</td>
</tr>
<tr>
<td>520</td>
<td>9</td>
<td>660</td>
<td>0.8</td>
</tr>
<tr>
<td>530</td>
<td>9.6</td>
<td>670</td>
<td>0.5</td>
</tr>
<tr>
<td>540</td>
<td>9.3</td>
<td>680</td>
<td>0</td>
</tr>
<tr>
<td>550</td>
<td>8.5</td>
<td>690</td>
<td>0</td>
</tr>
<tr>
<td>560</td>
<td>7.7</td>
<td>700</td>
<td>0</td>
</tr>
</tbody>
</table>
16. Name the spectrum Green Phosphor Efficiency.

17. Repeat this operation for the Emission spectrum with the following data.

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Value (%)</th>
<th>Wavelength (nm)</th>
<th>Value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>380</td>
<td>0</td>
<td>534</td>
<td>97</td>
</tr>
<tr>
<td>460</td>
<td>0.73</td>
<td>538</td>
<td>95.4</td>
</tr>
<tr>
<td>462</td>
<td>0.97</td>
<td>540</td>
<td>94.8</td>
</tr>
<tr>
<td>464</td>
<td>1.26</td>
<td>545</td>
<td>90.6</td>
</tr>
<tr>
<td>466</td>
<td>1.64</td>
<td>550</td>
<td>83.5</td>
</tr>
<tr>
<td>468</td>
<td>2.11</td>
<td>555</td>
<td>75.5</td>
</tr>
<tr>
<td>470</td>
<td>2.69</td>
<td>560</td>
<td>67.7</td>
</tr>
<tr>
<td>472</td>
<td>3.41</td>
<td>565</td>
<td>59.8</td>
</tr>
<tr>
<td>474</td>
<td>4.28</td>
<td>570</td>
<td>52.7</td>
</tr>
<tr>
<td>476</td>
<td>5.34</td>
<td>580</td>
<td>39.5</td>
</tr>
<tr>
<td>478</td>
<td>6.6</td>
<td>590</td>
<td>29.7</td>
</tr>
<tr>
<td>480</td>
<td>8.09</td>
<td>600</td>
<td>22.1</td>
</tr>
<tr>
<td>490</td>
<td>19.9</td>
<td>610</td>
<td>15.4</td>
</tr>
<tr>
<td>500</td>
<td>40.1</td>
<td>620</td>
<td>11.5</td>
</tr>
<tr>
<td>510</td>
<td>66.1</td>
<td>630</td>
<td>8.06</td>
</tr>
<tr>
<td>520</td>
<td>89.2</td>
<td>640</td>
<td>6.41</td>
</tr>
<tr>
<td>522</td>
<td>93.7</td>
<td>650</td>
<td>4.04</td>
</tr>
<tr>
<td>524</td>
<td>96.2</td>
<td>660</td>
<td>3.19</td>
</tr>
<tr>
<td>526</td>
<td>97.1</td>
<td>670</td>
<td>2.72</td>
</tr>
<tr>
<td>528</td>
<td>98.3</td>
<td>680</td>
<td>1.71</td>
</tr>
<tr>
<td>529</td>
<td>100</td>
<td>690</td>
<td>1</td>
</tr>
<tr>
<td>530</td>
<td>99.1</td>
<td>700</td>
<td>0.83</td>
</tr>
<tr>
<td>532</td>
<td>98.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
18. Name the spectrum Green Phosphor Emission.

19. In the Scattering properties tab, click Give scattering coefficient and phase function of the medium, and then Define phase function using Henyey-Greenstein formula.

   The Scattering variation and the Scattering phase function tabs are added.

20. In the Scattering variation tab, enter the following diffusion coefficients using + to add cells.
21. Set the anisotropic factor equals to 0.3 in the Scattering phase function tab.

22. Validate the dye definition by closing the window.

23. Add a new dye.


25. The Dye box appears.

26. Type Red phosphor pigment in the Description box.

27. Define the dye with the same scattering properties as the green phosphor pigment, using the following data.

Red Phosphor Absorption:

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Absorption coefficient (mm⁻¹)</th>
<th>Wavelength (nm)</th>
<th>Absorption coefficient (mm⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>360</td>
<td>4.69</td>
<td>490</td>
<td>4.53</td>
</tr>
<tr>
<td>380</td>
<td>4.99</td>
<td>500</td>
<td>4.1</td>
</tr>
<tr>
<td>400</td>
<td>5.03</td>
<td>510</td>
<td>3.49</td>
</tr>
<tr>
<td>450</td>
<td>5.05</td>
<td>520</td>
<td>2.76</td>
</tr>
<tr>
<td>460</td>
<td>5.02</td>
<td>530</td>
<td>1.99</td>
</tr>
<tr>
<td>470</td>
<td>4.94</td>
<td>540</td>
<td>1.29</td>
</tr>
<tr>
<td>480</td>
<td>4.79</td>
<td>550</td>
<td>0</td>
</tr>
</tbody>
</table>
Red Phosphor Efficiency:

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Value (%)</th>
<th>Wavelength (nm)</th>
<th>Value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>430</td>
<td>0</td>
<td>570</td>
<td>6.5</td>
</tr>
<tr>
<td>440</td>
<td>0</td>
<td>580</td>
<td>7.7</td>
</tr>
<tr>
<td>450</td>
<td>0</td>
<td>590</td>
<td>8.5</td>
</tr>
<tr>
<td>460</td>
<td>0</td>
<td>600</td>
<td>9.3</td>
</tr>
<tr>
<td>470</td>
<td>0.5</td>
<td>610</td>
<td>9.6</td>
</tr>
<tr>
<td>480</td>
<td>0.8</td>
<td>620</td>
<td>9</td>
</tr>
<tr>
<td>490</td>
<td>1</td>
<td>630</td>
<td>8</td>
</tr>
<tr>
<td>500</td>
<td>1.5</td>
<td>640</td>
<td>6</td>
</tr>
<tr>
<td>510</td>
<td>1.6</td>
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<td>4.5</td>
</tr>
<tr>
<td>520</td>
<td>2.2</td>
<td>660</td>
<td>3</td>
</tr>
<tr>
<td>530</td>
<td>2.7</td>
<td>670</td>
<td>1.9</td>
</tr>
<tr>
<td>540</td>
<td>3.7</td>
<td>680</td>
<td>1</td>
</tr>
<tr>
<td>550</td>
<td>4.5</td>
<td>690</td>
<td>0.8</td>
</tr>
<tr>
<td>560</td>
<td>5.7</td>
<td>700</td>
<td>0</td>
</tr>
</tbody>
</table>
Red Phosphor Emission:

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Value (%)</th>
<th>Wavelength (nm)</th>
<th>Value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>0</td>
<td>595</td>
<td>96.16</td>
</tr>
<tr>
<td>502</td>
<td>1.86</td>
<td>600</td>
<td>98.5</td>
</tr>
<tr>
<td>504</td>
<td>1.9</td>
<td>605</td>
<td>99.3</td>
</tr>
<tr>
<td>506</td>
<td>2.08</td>
<td>610</td>
<td>99.4</td>
</tr>
<tr>
<td>508</td>
<td>2.2</td>
<td>615</td>
<td>98.4</td>
</tr>
<tr>
<td>510</td>
<td>2.51</td>
<td>620</td>
<td>97.5</td>
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<tr>
<td>512</td>
<td>2.76</td>
<td>625</td>
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<tr>
<td>514</td>
<td>3.19</td>
<td>630</td>
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<tr>
<td>516</td>
<td>3.7</td>
<td>635</td>
<td>86.5</td>
</tr>
<tr>
<td>518</td>
<td>4.3</td>
<td>640</td>
<td>82.9</td>
</tr>
<tr>
<td>520</td>
<td>5.1</td>
<td>650</td>
<td>72.7</td>
</tr>
<tr>
<td>525</td>
<td>7.43</td>
<td>660</td>
<td>63.2</td>
</tr>
<tr>
<td>530</td>
<td>10.85</td>
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<tr>
<td>535</td>
<td>15.07</td>
<td>680</td>
<td>44.3</td>
</tr>
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<td>540</td>
<td>20.7</td>
<td>690</td>
<td>35.2</td>
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<td>545</td>
<td>27.5</td>
<td>700</td>
<td>28.13</td>
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<tr>
<td>550</td>
<td>34.8</td>
<td>710</td>
<td>23.5</td>
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<tr>
<td>555</td>
<td>42.16</td>
<td>720</td>
<td>19.79</td>
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<tr>
<td>560</td>
<td>50.61</td>
<td>730</td>
<td>16.16</td>
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<tr>
<td>565</td>
<td>58.98</td>
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<td>Wavelength (nm)</td>
<td>Value (%)</td>
<td>Wavelength (nm)</td>
<td>Value (%)</td>
</tr>
<tr>
<td>-----------------</td>
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<td>-----------</td>
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<tr>
<td>570</td>
<td>68.72</td>
<td>750</td>
<td>10.54</td>
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<td>575</td>
<td>75.33</td>
<td>760</td>
<td>9.1</td>
</tr>
<tr>
<td>580</td>
<td>80.5</td>
<td>770</td>
<td>7.1</td>
</tr>
<tr>
<td>585</td>
<td>87.27</td>
<td>780</td>
<td>5.77</td>
</tr>
<tr>
<td>590</td>
<td>92</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

28. Save the material as Phosphor mixture.material.

**Lesson 3: Applying Optical Properties**

1. Open the Body part.
2. Right-click Part Preferences, and then select Edit.
   
   The PropertyManager appears.
3. Open the Simple Scattering Surface Editor and set the body surface quality as follows.

![Simple Scattering Surface Editor](image)

4. Save the file as Body_surface.simplescattering in the project folder.

5. In the PropertyManager, in the Surface quality box, browse the newly created file.

   The new preferences appear in the OptisWorks tree by double-clicking Part Preferences.

6. Select the surfaces in contact with the Cavity part

   ![Surface Selection](image)

7. Right-click on these selection.

8. Go to OptisWorks.

9. Set an external material using the phosphor material previously created.

   The new material appears in the OptisWorks tree by double-clicking Materials.

10. Open the Cavity part.

11. Edit the part preferences and set the internal material with the Phosphor mixture material.

   The new preferences appear in the OptisWorks tree.

12. Select the surfaces in contact with the Body and Cavity parts and set a surface quality using the transparent.transparent file located in the Surface folder, itself in the Library folder.
The new surface quality appears in the OptisWorks tree by double-clicking Surface Quality.

13. Open the Chip part, and then edit the part preferences.

14. Open the Simple Scattering Surface Editor, and then set the cavity surface quality as follows.

15. Save the file as Absorber.simplescattering in the project folder.

16. Browse the newly created file to set the surface quality of the Chip part.

The new preferences appear in the OptisWorks tree.

17. Select the surfaces in contact with the Cavity part and set an external material using the phosphor material previously created.
Lesson 4: Creating a LED Source

1. Click Surface Source Definition (Optical Properties). The PropertyManager appears.
2. Type Chip emission in the Source name box.
3. Select the top and side surfaces of the chip as follows.
4. Under Flux, type 52 in the box, and then click Lumen.
5. Let the default intensity settings.
6. Open the Spectrum Editor.
7. Click to add cells and enter the following data.

<table>
<thead>
<tr>
<th>Lambda (nm)</th>
<th>Value (%)</th>
<th>Lambda (nm)</th>
<th>Value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>380</td>
<td>0</td>
<td>454</td>
<td>100</td>
</tr>
<tr>
<td>420</td>
<td>0</td>
<td>456</td>
<td>98.7</td>
</tr>
<tr>
<td>426</td>
<td>0.06</td>
<td>458</td>
<td>90.6</td>
</tr>
<tr>
<td>428</td>
<td>0.17</td>
<td>464</td>
<td>45.6</td>
</tr>
<tr>
<td>430</td>
<td>0.43</td>
<td>470</td>
<td>12</td>
</tr>
<tr>
<td>434</td>
<td>2.2</td>
<td>474</td>
<td>3.4</td>
</tr>
<tr>
<td>440</td>
<td>14.7</td>
<td>476</td>
<td>1.66</td>
</tr>
<tr>
<td>Lambda (nm)</td>
<td>Value (%)</td>
<td>Lambda (nm)</td>
<td>Value (%)</td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td>446</td>
<td>51.4</td>
<td>484</td>
<td>0.04</td>
</tr>
<tr>
<td>450</td>
<td>83</td>
<td>488</td>
<td>0</td>
</tr>
<tr>
<td>452</td>
<td>94</td>
<td>780</td>
<td>0</td>
</tr>
</tbody>
</table>

8. Save the spectrum file as LED blue emission.spectrum.
9. In the PropertyManager, under Spectrum, click Library, and then browse in the box the LED blue emission spectrum file.
11. Click OK.
   The new surface source appears in the OptisWorks tree by double-clicking Sources, Photometric sources.
12. Go back in the assembly.

**Lesson 5: Creating a Ray Tracing**

This page shows how to launch and change the parameters of a ray tracing.

1. Click Ray Tracing Complete Update (Ray Tracing).

   ![Image of ray tracing](image.png)

   We observe that the number of interactions is not high enough to let the rays go outside the cavity.

2. In the OptisWorks tree, double-click Simulations.
3. Right-click Simulation parameters, and then select Edit.
   The PropertyManager appears.
4. Under Propagation, type 500 in the Max impacts box.
5. Click OK.
6. Right-click Interactive simulation, and then select Edit.
7. Type 500 in the Max impacts box.
8. Click OK.
9. To observe the following results, click Ray Tracing Complete Update (Ray Tracing).
Lesson 6: Creating an Illuminance Detector

1. In the FeatureManager design tree, select Top Plane.
2. Click Insert, Reference Geometry, Plane to create a new one.
   The PropertyManager appears.
3. Type 3 in the Dimension box.
4. Click OK ✅.
5. Select the newly created plane, and then sketch a central point with two orthogonal construction lines along the X and Z axes.

6. Validate the sketch definition.

7. Click Illuminance Detector Definition (Detectors).

8. Under Geometry, click 1 point – 2 lines.

9. Select the following points to define the center and the X and Y directions of the map by clicking them in the graphics area.

10. Under Type of detector, click Colorimetric detector.

11. Under Spectral data, type 400 in the Lambda min box and 700 in the Lambda max box.

12. Under Map Size, type -5 in the X min box, 5 in the X max box, -5 in the Y Min box and 5 in the Y Max box.

13. Click OK.

The new detector appears in the OptisWorks tree by double-clicking Detectors, Illuminance / Irradiance detectors, 2D maps.

Lesson 7: Creating an Intensity Detector

1. Click Intensity Detector Definition (Detectors).
The PropertyManager appears.

2. Select the center of the map, the X and Y directions as follows by clicking them in the graphics area.

3. Let the default settings.

4. Click OK.

The new detector appears in the OptisWorks tree by double-clicking Detectors, Intensity detectors, 2D intensity maps.

Lesson 8: Launching a Direct Simulation

1. In the OptisWorks tree, double-click Simulations.

2. Right-click Direct simulation, and then select Edit.

   The PropertyManager appears.

3. Under Number of emitted rays, type 10, and then select Mega-rays from the list.

4. Click OK.

5. Right-click Direct simulation, and then select Run.

   It takes fifty minutes on a desktop computer.
6. To open the results, double-click Result Manager, Photometric results, Illuminance / Irradiance results, 2D maps, DEFAULT, the result and Result Manager, Intensity results, 2D intensity maps, DEFAULT, the result.

**Lesson 9: Analyzing Results**

1. Double-click the 2D Illuminance map result to open it in the Virtual Photometric Lab.

2. Click Tools, Color Rendering Index (CRI)... to display the Color rendering index box.

   - This box presents the 15 test samples defined by the CIE.
   - The first column corresponds to the test sample number.
   - The third one corresponds to the appearance of the test sample illuminated by the D65 illuminant.
   - The fourth column shows the color of the sample illuminated by the reference illuminant, used to calculate the
General Color Rendering Index and changing according to the spectral data.
The fifth column shows the color of the sample illuminated by the present spectrum.
The final column gives the color rendering index of the sample.

3. Click Tools, Measures... to display the Measures box.
4. Click Colorimetric data.

The General Color Rendering Index and the corresponding illuminant are indicated in the bottom right corner of the box which appears.
Using Thermic Surface Sources to Analyze an Infrared System

You must have the LM4 option and the SKY option (only for Part 1, Lesson 3).

This tutorial aims at illustrating the use of thermic surface sources to analyze an infrared system.

1 hour 30 minutes

In this exercise, you are going to generate the image of a tank under a night sky illumination. The second project uses the simulation result to study the infrared noise in a camera detection.

Part 1: Night Scene

Lesson 1: Checking the Optical Properties

1. Open the thermic_sources_part1.SLDASM file.
   This file is located in the Part1 folder of OW_Tutorials_Thermic_Surface_Source.zip (http://portal.optis-world.com/documentation/UG/OW/ZIP/OW_Tutorials_Thermic_Surface_Source.zip).
   In the OptisWorks tree, double-click Default part preferences.
2. Right-click the Body part, and then select Edit part preferences.
   The PropertyManager appears.
3. In the Surface quality box, browse the Shell.scattering file located in the SPEOS input file folder.
4. Click OK.
5. When a box explaining you that OptisWorks will update all selected parts with the new preference appears, click OK.
   The surface quality is different when viewing the OptisWorks tree.
6. Repeat the previous steps for:
   • the Canon part, changing its surface quality for Shell.scattering;
   • the Caterpillar_left part, changing its surface quality for Caterpillar.simplescattering;
   • the Caterpillar_right part, changing its surface quality for Caterpillar.simplescattering;
   • the Ground part, changing its surface quality for Ground.simplescattering;
7. Open the Caterpillar_left.SLDPRT file.
8. Select the following function, and then create a new surface quality.
9. Apply Tires.simplescattering to the selected surfaces.
10. Click OK.
11. Save and close the Caterpillar_left.SLDPRT file.
12. Repeat the previous steps for the Caterpillar_right part.
Lesson 2: Creating Thermic Surface Sources

1. Open the Body part.

2. Click Thermic Surface Source Definition (Optical Properties).
   The PropertyManager appears.

3. Type Shell_body in the Source name box.

4. Select all the surfaces of the tank geometry except two as follows by clicking them in the graphics area.

5. Under Parameters, type 300 in the Temperature(K) box.

6. Click OK.

7. Click Thermic Surface Source Definition (Optical Properties).

8. Type Shell_motor in the Source name box.

9. Select the following surfaces by clicking them in the graphics area.

10. Under Parameters, type 350 in the Temperature (K) box.

11. Click OK.

12. Save, and then close the Body.SLDPRT file.

13. Repeat the previous steps for:
   - the Canon part.
<table>
<thead>
<tr>
<th>Source name</th>
<th>Caterpillar_left</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissive faces</td>
<td>Face&lt;68&gt;</td>
</tr>
<tr>
<td>Parameters</td>
<td>Temperature (K): 300</td>
</tr>
<tr>
<td></td>
<td>Power (W): 17223.34313357</td>
</tr>
</tbody>
</table>

- the Caterpillar_left part.

<table>
<thead>
<tr>
<th>Source name</th>
<th>Caterpillar_right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emissive faces</td>
<td>Face&lt;68&gt;</td>
</tr>
<tr>
<td>Parameters</td>
<td>Temperature (K): 300</td>
</tr>
<tr>
<td></td>
<td>Power (W): 17223.34313357</td>
</tr>
</tbody>
</table>

- the Caterpillar_right part.
Lesson 3: Creating an Ambient Source

1. Click New Ambient Source (Additional Features). The PropertyManager appears.
2. Type Night sky in the Ambient source name box.
3. Under Parameters, select Natural Light from the Type list.
4. Define the Zenith and the North axis using the following construction lines and orientation.
5. Change the Date and time settings as follows.

![Location and Time Zone](image)

6. Click OK.

The new ambient source appears in the OptisWorks tree by double-clicking Sources, Ambient sources.

**Lesson 4: Creating a Luminance Detector**

1. Click Luminance Detector Definition (Detectors).
   The PropertyManager appears.
2. Type Camera in the Detector name box.
3. Under Geometry, click 1 point - 2 lines.
4. Select the point and the two lines as follows by clicking them in the graphics area.

![Diagram](image)

5. Under Luminance plane, type 240 in the Distance box, 42 in the Width box and 42 in the Height box.
6. Under Spectral data, type 800 in the Lambda min box, 1400 in the Lambda max box and 13 in the Sampling box.
7. Select the Save spectral data (for Inverse simulation only) check box.
8. Under Sampling, type 400 in the X box and 400 in the Y box.

9. Click OK ✓.

The new detector appears in the OptisWorks tree by double-clicking Detectors, Luminance / Radiance detectors, 2D maps.

Lesson 5: Launching an Inverse Simulation

1. In the OptisWorks tree, double-click Simulations.

2. Right-click Inverse simulation, and then select Run or directly click Inverse Simulation  (Simulations).

   The simulation takes roughly forty minutes on a desktop computer.

3. In the OptisWorks tree, to open the result, double-click Result Manager, Photometric results, Luminance/Radiance results, 2D maps, DEFAULT, CAMERA.
4. To observe the following result, click View, Radiometric units.

5. Copy the result in the SPEOS input file folder. You have to create the folder OW_BP_Thermic_Source.

   The path of this folder is ...\OW_BP_Thermic_Source\Part 2.

Part 2: Infrared Camera

Lesson 1: Checking the Optical Properties

1. Open the thermic_sources_part2.SLDASM file.

   This file is located in the Part2 folder of OW_Tutorials_Thermic_Surface_Source.zip

2. In the OptisWorks tree, double-click Default part preferences.

3. Right-click the Lens1 part, and then select Edit part preferences.

   The PropertyManager appears.

4. In the Internal material box, browse the SF5.material file located in the SPEOS input file folder.

5. Click OK.

6. When a box explaining you that OptisWorks will update all selected parts with the new preferences appears, click OK.

   The internal material is different when viewing the OptisWorks tree.

7. Repeat the previous steps for:
   - the Lens2 part, changing its internal material for BK7.material;
   - the Lens3 part, changing its internal material for BASF64A.material;
   - the Lens4 part, changing its internal material for SF66.material;
   - the Mount part, changing its surface quality for Mount.simplescattering;
   - the PCB part, changing its surface quality for Absorber.simplescattering;
   - the Rings part, changing its surface quality for Rings.simplescattering;
   - the Sensor part, changing its surface quality for Absorber.simplescattering;

9. Select the surface in contact with the Lens2 part, and then create a new external material by applying the BK7.material file.

![](sets_external_material.png)

10. Click OK ✔.

    The new material appears in the OptisWorks tree by double-clicking Materials.

11. Save, and then close the Lens1.SLDPRT file.


13. Select the surface in contact with the Lens1 part, and then set a surface quality using the transparent.transparent file located in the Surface folder, itself in the Library folder.

![](sets_surface_quality.png)

14. Click OK ✔.

15. Save, and then close the Lens2.SLDPRT file.

    The new surface quality appears in the OptisWorks tree by double-clicking Surface Quality.


17. Select the surface in contact with the Lens4 part, and then create a new external material by applying the SF66.material file.
18. Click OK ✓.
   The new material appears in the OptisWorks tree by double-clicking Materials.

19. Save, and then close the Lens3.SLDPRT file.


21. Select the surface in contact with the Lens3 part, and then set a surface quality using the transparent.transparent file located in the Surface folder, itself in the Library folder.

22. Click OK ✓.
   The new surface quality appears in the OptisWorks tree by double-clicking Surface Quality.

**Lesson 2: Creating a Surface Source**

1. Open the Source part.

2. Click Surface Source Definition (Optical Properties).
   The PropertyManager appears.

3. Type Scene in the Source name box.
4. Select the square surface as the emissive face by clicking it in the graphics area as follows.

5. Under Flux, type 0.0009 in the box, and then click Lumen.
6. Under Emittance, click Variable (XMP), and then browse in the box the XMP file previously generated.
7. Under Intensity, click Lambertian.
8. Type 5 in the Limited half angle box.
10. Click OK ✅.

The new source appears in the OptisWorks tree by double-clicking Sources, Photometric sources.

**Lesson 3: Creating Thermic Surface Sources**

1. Open the Mount part.
2. Click Thermic Surface Source Definition (Optical Properties).
   The PropertyManager appears.
3. Type Mount in the Source name box.
4. Select the surfaces 3 to 9 by clicking them in the graphics area.
5. Under Parameters, type 300 in the Temperature (K) box.
6. Click OK ✅.
7. Save, and then close the Mount.SLDPRT file.
8. Repeat the previous steps for the Rings part, selecting surfaces 1 to 6 and setting the blackbody temperature to 300K.

1. Go back in the assembly.
Lesson 4: Launching a Ray Tracing

1. Click Ray Tracing Complete Update (Ray Tracing).

2. Right-click the Scene surface source, and then select Switch Off For The Ray Tracing.

3. To observe the rays coming from the Mount and Rings parts, illustrating the infrared noise, click Ray Tracing Complete Update (Ray Tracing).

Lesson 5: Creating an Illuminance Detector

1. Click Illuminance Detector Definition (Detectors).
   The PropertyManager appears.

2. Under Geometry, click 1 point - 2 lines.
3. Select the point and the two lines by clicking them in the graphics area as follows.

4. Type Sensor in the Detector name box.
5. Under Type of detector, click Radiometric detector.
6. Under Map Size, type -2 in the X min box, 2 in the X max box, -2 in the Y Min box, 2 in the Y Max box.
7. Under Sampling, type 400 in the X box and 400 in the Y box.
8. Under Axis, select the Inverts Y axis check box and the Inverts Z axis check box.
9. Click OK.

   The new detector appears in the OptisWorks tree by double-clicking Detectors, Illuminance / Irradiance detectors.

**Lesson 6: Launching a Direct Simulation**

1. In the OptisWorks tree, under Simulation, right-click Direct Simulation, and then select Edit.

   The PropertyManager appears.

2. Ensure that the number of emitted rays is equal to one hundred mega-rays.

3. Right-click Direct Simulation, and then select Run.

   The simulation takes roughly ten minutes on a desktop computer.
4. In the OptisWorks tree, to open the result, double-click Result Manager, Photometric results, Illuminance/Irradiance results, 2D maps, DEFAULT, SENSOR.
Lesson 7: Analyzing the Result

This lesson shows how to obtain the signal to noise ratio of an optical system.

1. In the Virtual Photometric Lab, to edit the Virtual Lighting Controller, click Tools, Sources operations...
2. The Virtual Lighting Controller appears.
3. Clear the Mount<1>Mount check box and the Rings<1>Rings check box.
4. Click File, Export to save the map as Signal.xmp.
5. Ensure that the Merge active layer(s) check box is selected before clicking OK.
6. Edit the Virtual Lighting Controller and select all the sources except the scene surface source.
7. Click File, Export to save the map as Noise.xmp.
8. Ensure that the Merge active layer(s) check box is selected before clicking OK.
10. Select Signal.xmp and Noise.xmp as source files.
11. Choose the Signal to noise ratio operation.
12. Save the result as SignalToNoiseo.xmp.
13. Click Process, and then open the result
14. Remove the filtering.

15. Change the maximum scale value to one hundred to visualize a clearer signal to noise ratio result.
Using a Gradient Index Material

You must have the LM2 package.

1. Launch OptisWorks.
2. Edit the User Material Editor in OptisWorks\New Optical Properties Definition.
3. Select Gradient Index from the Material Type list.
4. In the A field box, type 0.499.
5. Save it as GradientIndex.
6. Close the User Material Editor.
8. Open the Fiber part.
   A new window appears.
9. From the Optical Properties tabulation, click Part Preferences.
10. In the Default Optical Properties group box, in the Internal material box, browse the material you have created.
    In Anisotropy axis group box, you can select the speed axis of the gradient index material setting the speed axis's normal plan.
11. Click OK.
    You come back in the GradientIndex.SLDASM assembly.
13. Do a Ray Tracing Complete Update.
    You can observe the propagation through the gradient index material.
14. Open the Fiber part.
    A new window appears.
15. From the Optical Properties tabulation, click Part Preferences.
16. In the Default Optical Properties group box, edit the Internal Material.
17. Go to the Scattering properties tabulation.
18. Check the Give scattering coefficient and phase function of the medium options with the Define phase function using Henyey-Greenstein formula option.
    This configuration gives a diffusing material.
19. Go to the Scattering variation tabulation.
20. Type the value 1 for the default values.
21. Go to the Scattering phase function.
22. Type the following value for the Anisotropy factor: 0.600.
23. Close and save the User Material Editor.
    You come back in the GradientIndex.SLDASM assembly.
25. Go to OptisWorks tabulation.
26. Check to have 50 maximum impacts for the Simulations\Simulation parameters and the Simulations\Interactive simulation.

27. Do a Ray Tracing Complete Update.

   You can observe the propagation through the gradient index material.

28. Change the value of the Impacts max by 500 for the Simulations\Simulation parameters and the Simulations\Interactive simulation.

   You can observe the following result.

### Setting Polarizer Surface

*You must have S_OWX_LM1, S_OWX_LM2 or S_OWX_LM4 solution with the O_OWX_POL option.*

With this tutorial, you are about to learn the polarization management in OptisWorks, applied for electronics applications.

You are about to create an anti-glaring filter on mobile screen composed by a linear polarizer and a quarter-wave plate.

*20 minutes*

### Lesson 1: Preparing Data

2. Extract files.
3. Open assembly OW_POLA_Mobile Phone.SLDASM.

### Lesson 2: Creating a Polarization Plate

1. Click Polarization plate  (Additional Feature).
   The property manager appears.
2. Rename as Polarizer in Polarization plate name group box.
3. Select, in geometry, parameters of Axis system definition group box as defined below:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Origin</td>
<td>Point1@POLARIZER@MOBILE_A-base-1</td>
</tr>
<tr>
<td>X Direction</td>
<td>Line1@POLARIZER@MOBILE_A-base-1</td>
</tr>
<tr>
<td>Y Direction</td>
<td>Line3@POLARIZER@MOBILE_A-base-1</td>
</tr>
</tbody>
</table>

   These parameters define the axis system and orientation of the polarization plate.
4. Set parameters of Geometry group box according to the following definition:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>X min</td>
<td>-27.8mm</td>
</tr>
</tbody>
</table>
These parameters define size of the polarization plate.

5. In the External material box, browse air.material situated in folder ...\OPTIS\LIBRARY\MATERIAL

6. From Windows start menu, click All Programs, OPTIS, OPTIS Labs, Optical Property Editors, Surface Optical Property Editors, Polarizer Surface Editor.

7. Write in Description box your comment, like:
   Linear polarizer - created by Author, Date

8. Set all reals part of Jones matrix to 1 and all imaginary part to 0
   For more details, you can view Polarizer Surface Editor.

9. Save your polarization file with .polarizer extension in Input folder of tutorial.
   You can save it as LinearPolarizer.polarizer

10. In the Jones matrix box, browse the LinearPolarizer.polarizer files.

11. Click OK.
    Polarizer is now set.
    You can create now the quarter-wave plate.

12. Click Polarization plate (Additional Feature).
    The property manager appears.

13. Rename as Quarter-wave in Polarization plate name group box.

14. Select, in geometry, parameters of Axis system definition group box as defined below:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Origin</td>
<td>Point1@QUARTER-WAVE@MOBILE_A-base-1</td>
</tr>
<tr>
<td>X Direction</td>
<td>Line1@QUARTER-WAVE@MOBILE_A-base-1</td>
</tr>
<tr>
<td>Y Direction</td>
<td>Line3@QUARTER-WAVE@MOBILE_A-base-1</td>
</tr>
</tbody>
</table>

This geometrical coordinate defines the orientation of quarter-wave plate axis.

15. Set parameters of Geometry group box according to the following definition:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>X min</td>
<td>-27.8mm</td>
</tr>
<tr>
<td>X max</td>
<td>27.8mm</td>
</tr>
<tr>
<td>Y min</td>
<td>-39.10mm</td>
</tr>
<tr>
<td>Y max</td>
<td>39.10mm</td>
</tr>
</tbody>
</table>

   These parameters define size of the quarter-wave plate.

16. In the External material box, browse air.material situated in folder ...\OPTIS\LIBRARY\MATERIAL

17. In the Polarization group box, select Quarter wave plate in Type list.

18. Click OK.
    Your quarter-wave plate is now set.
Lesson 3: Analysing Anti-glaring Filter with Ray Tracing

1. From the OptisWorks tree, select both Polarizer and Quarter-wave features situated under Polarization plates node.
2. Right-click.
3. Click Suppress.
4. From the OPTISWorks Manager tree, click Int.source_Light pencil, situated under sub-node Interactive Sources.
5. Click Ray Tracing complete update 

Light comes across front glass and reflects on upper surface of display. Reflected light is not stopped.

6. From the OptisWorks tree, select both Polarizer and Quarter-wave features situated under Polarization plates node.
7. Right-click.
8. Click Unsuppress.
9. From the OPTISWorks tree, click Int.source_Light pencil.
10. Click Ray Tracing complete update 

Light comes across front glass and goes through the polarizer. Output light is linearly polarized.

Light goes through the quarter-wave plate and becomes circular polarized. Then part of this light is reflected on an optical interface. The polarization phase is shifted by 180°.

Then the reflected light hits the quarter wave plate and is linearly polarized with its orientation crossed with the polarizer. Reflected light is finally stopped by the polarizer.
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