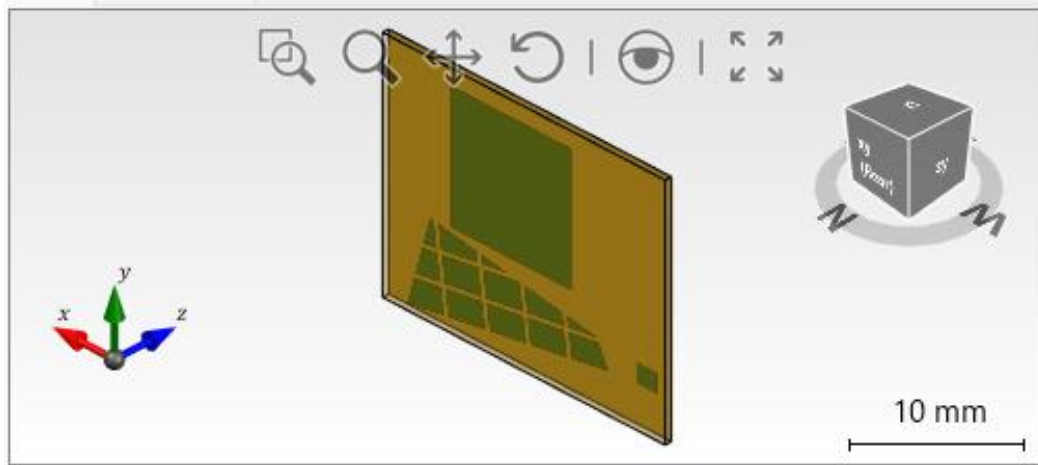


Gridded Segmentation of Grating Regions in Lightguide

Abstract



In lightguides, grating regions are sometimes implemented using gridded segmentation to facilitate specific structural or fabrication requirements. Here we demonstrate how to configure gridded segmentation within grating regions using VirtualLab Fusion.

Functional Grating

The screenshot displays the 'Edit Light Guide Component (Light Guide (After Surface Layout))' window. The 'Surface Layouts' tab is active, showing a table of surfaces. A red box highlights the 'Edit Surface Layout' button for the first surface. An arrow points from this button to the 'Edit Surface Layout' dialog. In this dialog, a 3D visualization shows a yellow surface with a green rectangular region and a red triangular region. A scale bar indicates 10 mm. Below the visualization is a table of regions:

#	Name of Region	Region Type	Period
1	Incoupling Grating	Rectangular Region	380 nm
2	Expansion Grating	Simple Polygon Region	268.7 nm
3	Outcoupling Grating	Rectangular Region	380 nm

Buttons for 'Edit', 'Add', 'Remove', 'Duplicate', and 'Gridded Segmentation' are on the right. An arrow points from the 'Edit' button to the 'Edit Grating Region' dialog. This dialog has three tabs: 'Shape', 'Region Channels', and 'Grating'. The 'Grating' tab is active, showing options for '1D-Periodic (Lamellar)' and '2D-Periodic'. The '1D-Periodic (Lamellar)' option is selected. The 'Grating Period' is set to 268.7 nm and the 'Orientation (Rotation about z-Axis)' is -45°. Below these are tabs for 'Order Selection' and 'Efficiencies'. The 'Efficiencies' tab is active, showing 'Constant' and 'Programmable' options. The 'Constant' option is selected. The 'Overall Transmission' is 0% and 'Overall Reflection' is 100%. At the bottom, there are two tables for efficiency data:

Order	Efficiency
R-1	10 %
R0	90 %

Order	Efficiency
R-1	10 %
R0	90 %

First, we introduce the segmentation of functional gratings. Functional gratings are characterized by efficiencies defined through either constant values or programmable functions. You can view or modify these definitions by clicking the *Edit* button.

Open the Gridded Segmentation Option

Diagram illustrating the process to open the Gridded Segmentation Option:

Step 1: Edit Light Guide Component (Light Guide (After Surface Layout))

The **Surface Layouts** tab is selected. The table shows two surfaces:

Surface Name	Edit	Info
1 Plane Surface	Edit Surface Layout	Surface layout containing 3 regions.
2 Plane Surface	Edit Surface Layout	Surface layout containing 0 regions.

The **Structure** icon is highlighted in the left sidebar.

Step 2: Edit Surface Layout

The **Gridded Segmentation** button is highlighted. The table below shows the regions defined for the surface layout:

#	Name of Region	Region Type	Period
1	Incoupling Grating	Rectangular Region	380 nm
2	Expansion Grating	Simple Polygon Region	268.7 nm
3	Outcoupling Grating	Rectangular Region	380 nm

Step 3: Parameters for Equidistant Segmentation

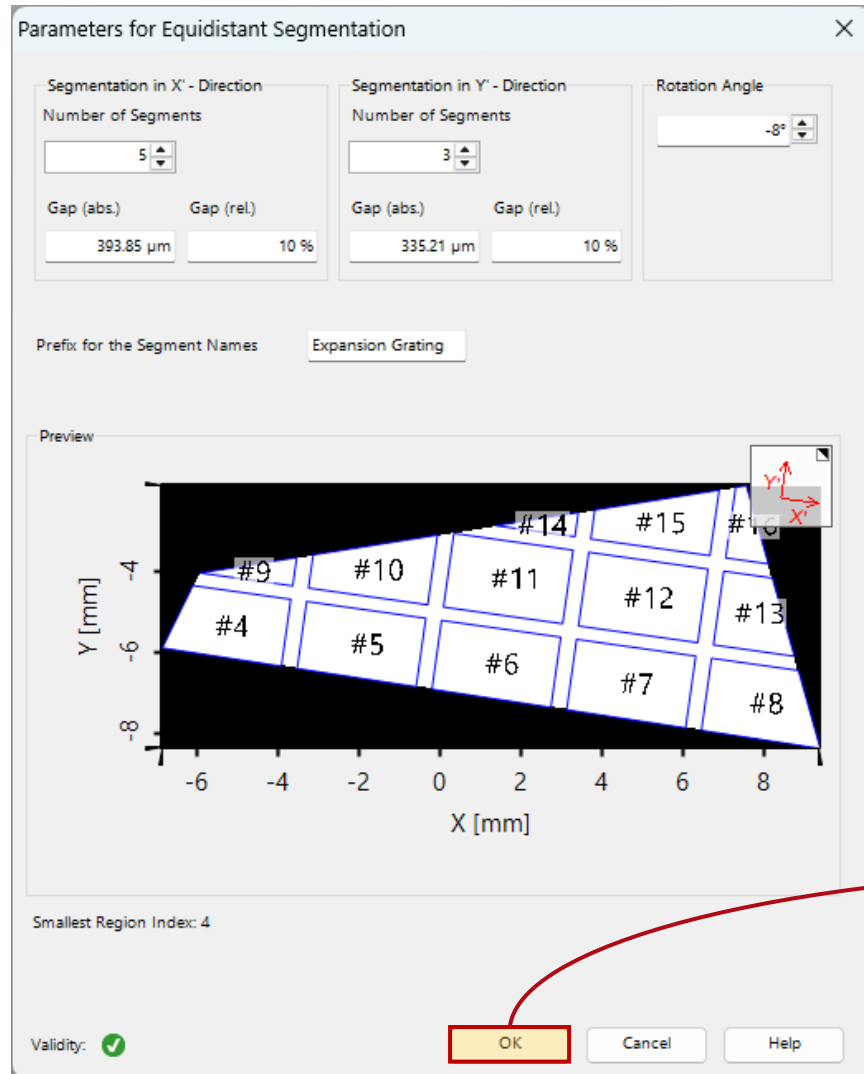
The **Parameters for Equidistant Segmentation** dialog is shown. The **Segmentation in X - Direction** and **Segmentation in Y - Direction** are both set to 1 segment. The **Gap (abs.)** is 0 mm and the **Gap (rel.)** is 0 %.

The **Preview** shows a graph of Y [mm] vs X [mm] with a white polygon labeled #4. The X-axis ranges from -6 to 8 mm, and the Y-axis ranges from -8 to -4 mm.

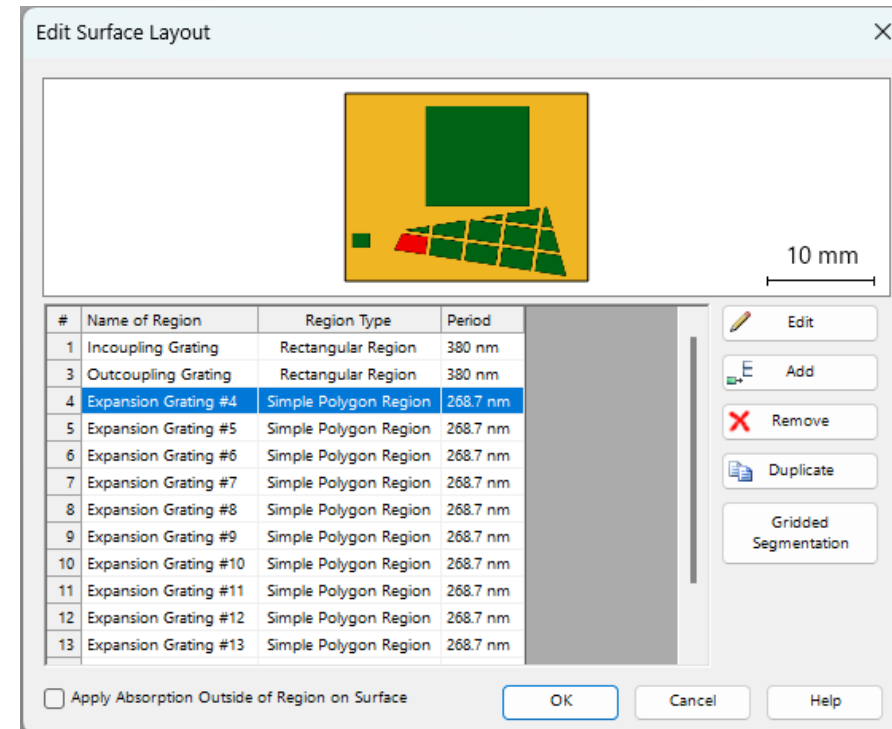
Smallest Region Index: 4

Validity:

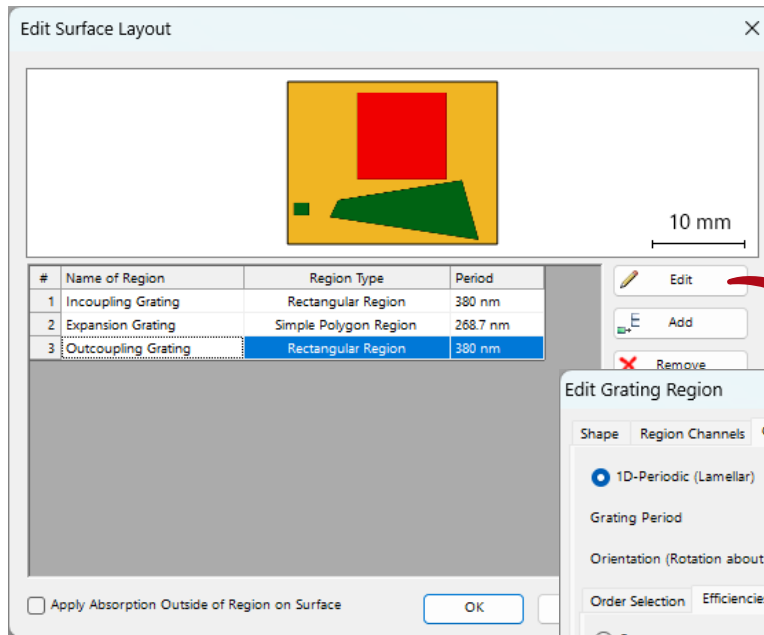
Segmentation of the Functional Grating



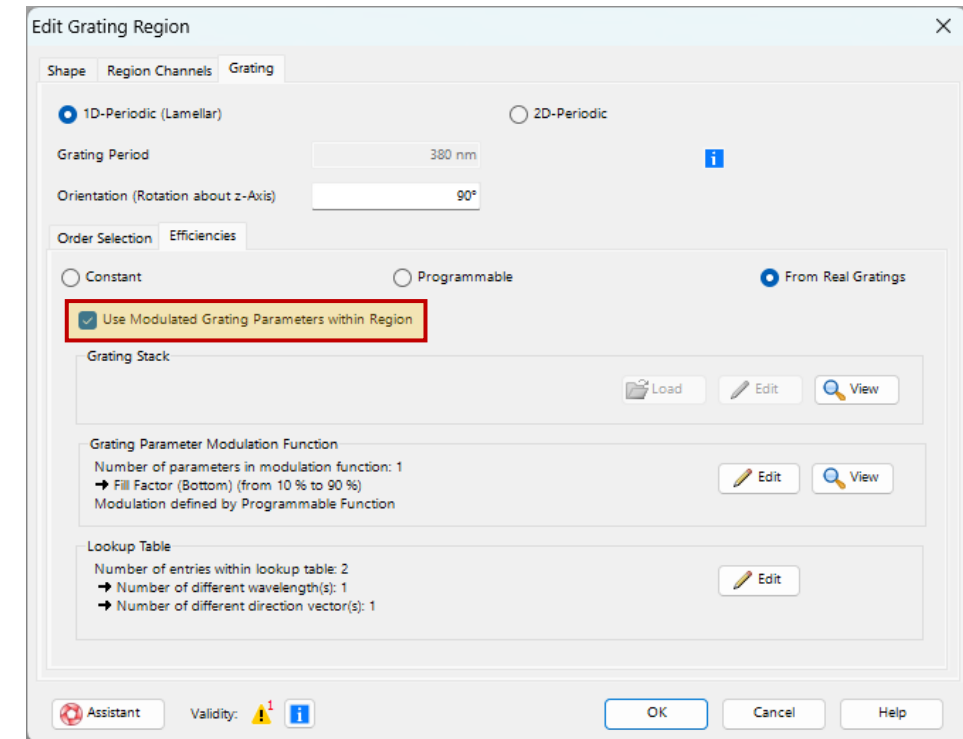
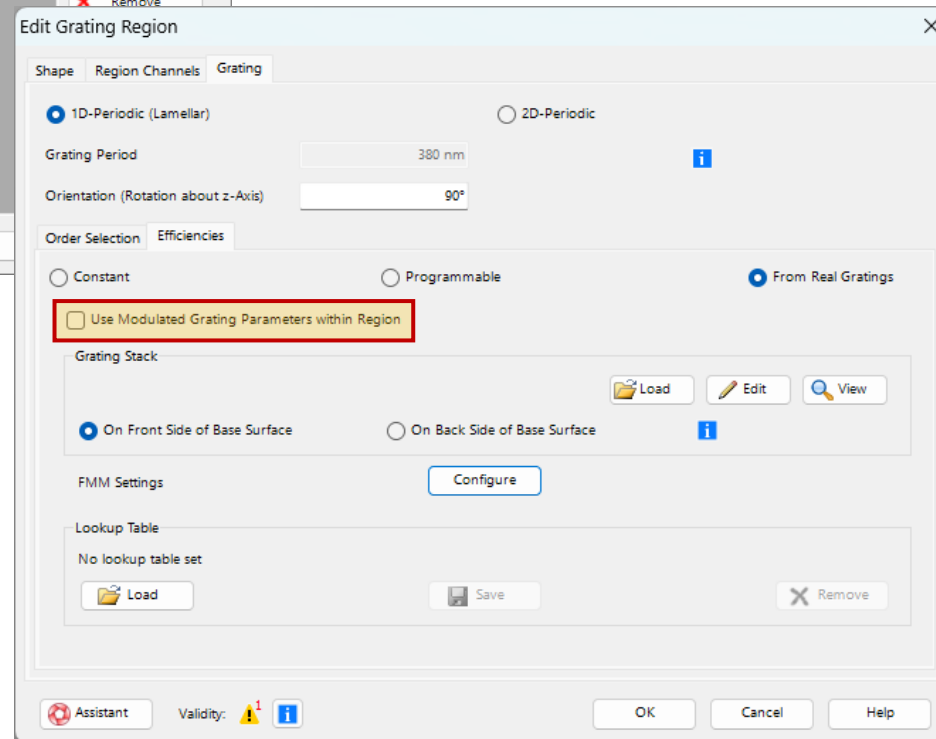
The shape of the gridded segmentation can be adjusted by modifying the *Number of Segments*, the *Gap* between them, and the *Rotation Angle*. Additionally, users can customize the segment name as needed.



Real Grating



Next, we introduce the segmentation of real gratings. In this case, the efficiencies are calculated based on the electromagnetic field response of the grating structure. The structure itself can be defined directly or generated through modulated grating parameters.



Segmentation of the Real Grating without Modulated Grating Parameters

Parameters for Equidistant Segmentation

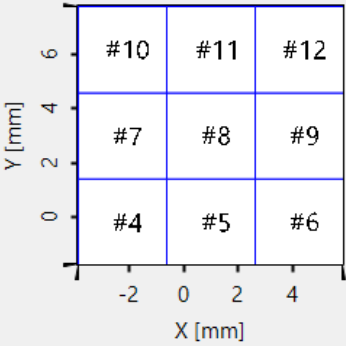
Segmentation in X - Direction
Number of Segments: 3
Gap (abs.): 0 mm, Gap (rel.): 0 %

Segmentation in Y - Direction
Number of Segments: 3
Gap (abs.): 0 mm, Gap (rel.): 0 %

Rotation Angle: 0°
Align With Sides

Prefix for the Segment Names: Outcoupler

Preview



Smallest Region Index: 4

Validity:

◀ Back Next ▶

OK Cancel Help

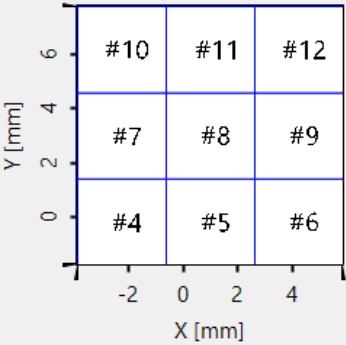
Parameters for Equidistant Segmentation

Select the Parameters to be Varied for the Segments:

Filter by... Show Only Varied Parameters

1	2	Parameter	Vary	Original Value
		Groove Material (Air) Constant Absorption Coefficient	<input type="checkbox"/>	0 m ⁻¹
		Groove Material (Air) Partial Pressure of Water Vapor	<input type="checkbox"/>	0 Pa
		Fill Factor (Bottom)	<input checked="" type="checkbox"/>	35 %
		z-Extension	<input type="checkbox"/>	165 nm
		Slant Angle	<input type="checkbox"/>	0°
		Surface #2 (Plane Surface)		

Preview



Smallest Region Index: 4

Validity:

◀ Back Next ▶

OK Cancel Help

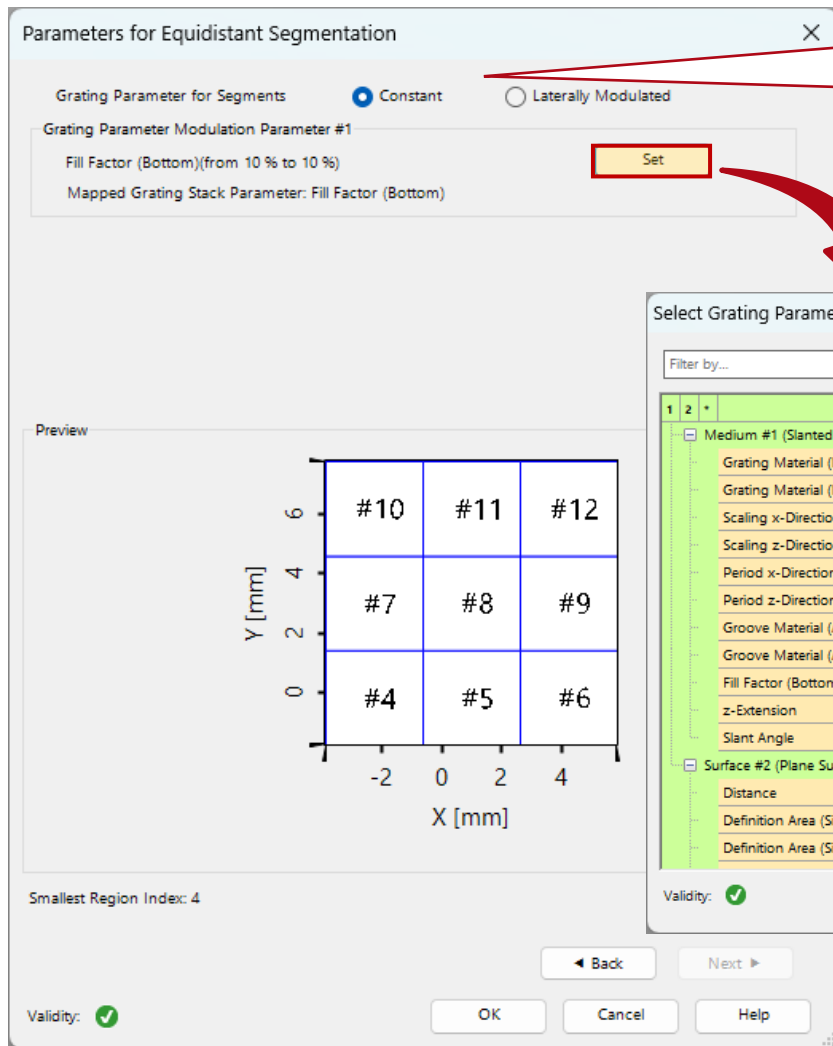
Parameters for Equidistant Segmentation

Set the Parameter Values per Segment:

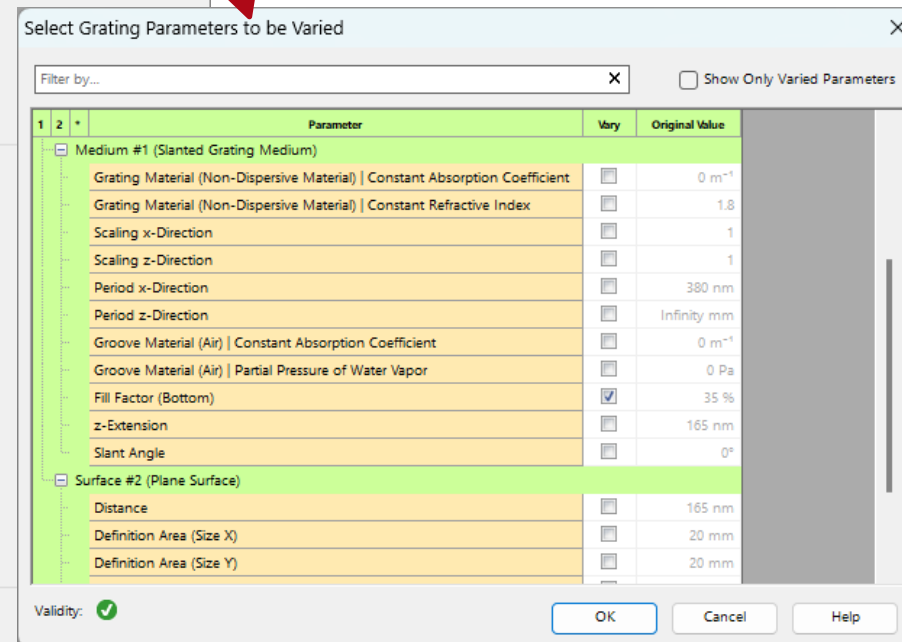
Parameter	Region #4	Region #5	Region #6	Region #7	Region #8	Region #9	Region #10	Region #11
Fill Factor (Bottom)	35 %	35 %	35 %	35 %	35 %	35 %	35 %	35 %

For real gratings do not involve modulated parameters, the user can choose which specific grating parameter to customize for each segment.

Segmentation of the Real Grating with Modulated Grating Parameters



For the grating with lateral modulated grating parameters, each segment can either maintain a continuous modulation or be divided into constant intervals, which can be calculated automatically.



If constant interval calculation is enabled, the user can then determine which parameter from the original grating will remain fixed within each segment.

Parameter Overview of the Segmented Grating

The screenshot displays the software interface for editing a segmented grating. The 'Edit Surface Layout' window shows a 2D layout of the grating regions with a 10 mm scale bar. The 'Parameter Overview' window provides a detailed view of the parameters for each region, including the grating stack and medium used. The 'Profile Editing & Run' tab is active, showing the 'Parameter Overview' sub-tab.

Edit Surface Layout

#	Name of Region	Region Type	Period
1	Incoupling Grating	Rectangular Region	380 nm
2	Expansion Grating	Simple Polygon Region	268.7 nm
4	Outcoupler #4	Simple Polygon Region	380 nm
5	Outcoupler #5	Simple Polygon Region	380 nm
6	Outcoupler #6	Simple Polygon Region	380 nm
7	Outcoupler #7	Simple Polygon Region	380 nm
8	Outcoupler #8	Simple Polygon Region	380 nm
9	Outcoupler #9	Simple Polygon Region	380 nm
10	Outcoupler #10	Simple Polygon Region	380 nm
11	Outcoupler #11	Simple Polygon Region	380 nm
12	Outcoupler #12	Simple Polygon Region	380 nm

Parameter Overview

1	2	Parameter	Value
"Light Guide (After Surface Layout)" (#1)			
Surface #1 (Plane Surface)			
		Surface Region #1 (Incoupling Grating) Grating Stack (Slanted Grating Incoupler) Medium #1 (Slanted	50 %
		Surface Region #4 (Outcoupler #4) Grating Stack (Binary Grating Outcoupler) Medium #1 (Slanted Grating	28.756 %
		Surface Region #5 (Outcoupler #5) Grating Stack (Binary Grating Outcoupler) Medium #1 (Slanted Grating	28.756 %
		Surface Region #6 (Outcoupler #6) Grating Stack (Binary Grating Outcoupler) Medium #1 (Slanted Grating	28.756 %
		Surface Region #7 (Outcoupler #7) Grating Stack (Binary Grating Outcoupler) Medium #1 (Slanted Grating	34.879 %
		Surface Region #8 (Outcoupler #8) Grating Stack (Binary Grating Outcoupler) Medium #1 (Slanted Grating	34.879 %
		Surface Region #9 (Outcoupler #9) Grating Stack (Binary Grating Outcoupler) Medium #1 (Slanted Grating	34.879 %
		Surface Region #10 (Outcoupler #10) Grating Stack (Binary Grating Outcoupler) Medium #1 (Slanted Grating	41.003 %
		Surface Region #11 (Outcoupler #11) Grating Stack (Binary Grating Outcoupler) Medium #1 (Slanted Grating	41.003 %
		Surface Region #12 (Outcoupler #12) Grating Stack (Binary Grating Outcoupler) Medium #1 (Slanted Grating	41.003 %

Profile Editing & Run

Profile Editor | **Parameter Overview** | Use Parameter Coupling

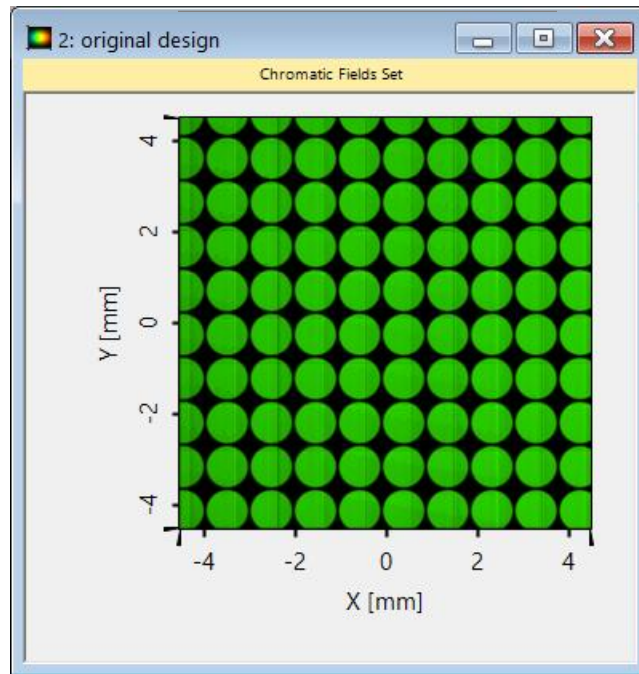
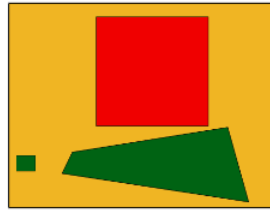
Settings

Validity: ☒ Show Minimum and Maximum Allowed Values

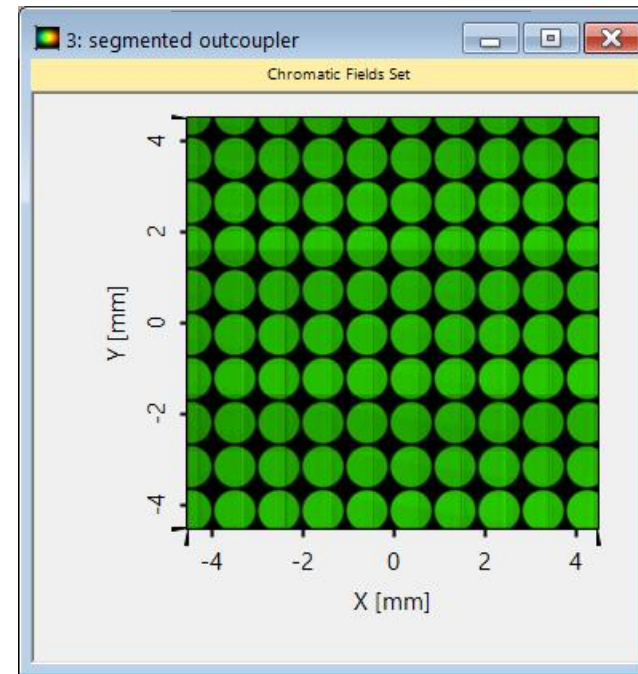
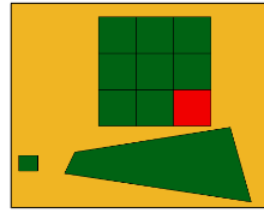
OK Cancel Help

The segmented grating regions are displayed in the *Edit Surface Layout* window. In *Parameter Overview* under *Profile Editing & Run* tab, the user can view which constant values have been assigned to each segment for the selected parameter.

Example for Constant Intervals vs Continuously Modulation



"Uniformity Detector" (#602) (Profile: General)	Minimum	129.23 (mV/m) ²
	Maximum	148.21 (mV/m) ²
	Uniformity Error	6.8408 %
	Arithmetic Mean	140.38 (mV/m) ²
	Standard Deviation	21.524 (mV/m) ²



"Uniformity Detector" (# 602) (Profile: General)	Minimum	129.27 (mV/m) ²
	Maximum	147.47 (mV/m) ²
	Uniformity Error	6.5788 %
	Arithmetic Mean	140.65 (mV/m) ²
	Standard Deviation	21.339 (mV/m) ²

An optimized lightguide is used here as an example. The fill factor of the outcoupler is segmented as shown on the last two pages. When compared to the original design, which features a continuously varying fill factor, the detector results reveal only minor differences.

Document Information

Title	Gridded Segmentation of Grating Regions in Lightguide
Document code	TUT.0457
Publication date	08.07.2025
Required packages	- (Though Grating Package is required if the grating regions shall be filled with real gratings).
Software version	2025.1 (Build 1.172)*
Category	Tutorial
Further reading	<u>Construction of a Light Guide</u> <u>Optimization of Lightguide with Continuously Modulated Grating Regions</u>

* The files attached to this document require the specific version or later.