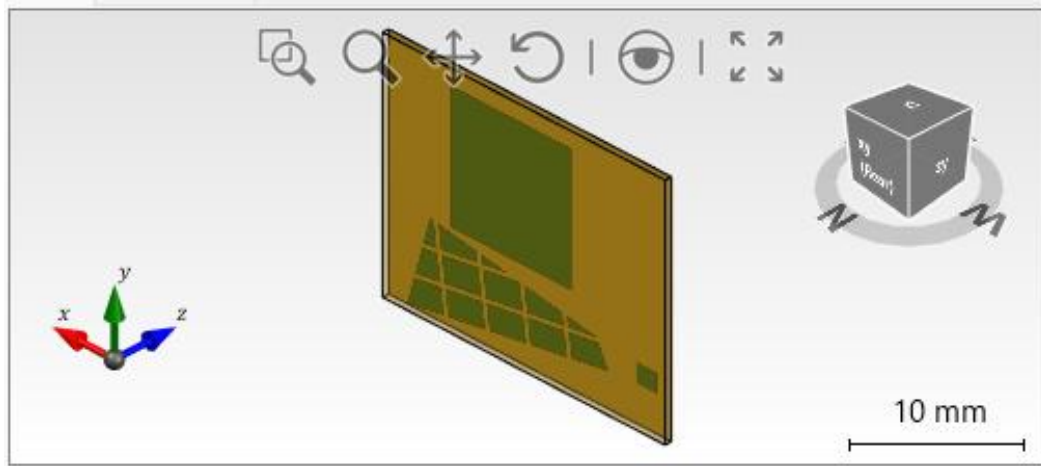


Gridded Segmentation of Grating Regions in Lightguide

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 with two surface entries. A red arrow points from the 'Edit Surface Layout' button in the table to the 'Edit Surface Layout' dialog box. The dialog box shows a 3D visualization of the surface layout with a 10 mm scale bar and a table of regions. A red arrow points from the 'Edit' button in the dialog to the 'Edit Grating Region' dialog box. The 'Edit Grating Region' dialog box shows the 'Grating' tab with the '1D-Periodic (Lamellar)' shape selected. The 'Constant' efficiency option is highlighted with a red box. The 'Efficiencies' tab shows the 'Overall Transmission' and 'Overall Reflection' sliders, and two tables for 'From Front Side' and 'From Back Side' efficiencies.

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.

#	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

Order	Efficiency
R-1	10 %
R0	90 %

Open the Gridded Segmentation Option

Diagram illustrating the process to open the Gridded Segmentation Option in a software interface.

The main window is **Edit Light Guide Component (Light Guide (After Surface Layout))**. It shows a table of 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.

A red arrow points from the **Edit Surface Layout** button in the table to the **Edit Surface Layout** dialog box.

The **Edit Surface Layout** dialog box shows a preview of the surface layout and 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

A red arrow points from the **Gridded Segmentation** button in the **Edit Surface Layout** dialog box to the **Parameters for Equidistant Segmentation** dialog box.

The **Parameters for Equidistant Segmentation** dialog box shows settings for segmentation in X and Y directions, rotation angle, and a preview of the segmented region.

Segmentation in X - Direction:

- Number of Segments: 1
- Gap (abs.): 0 mm
- Gap (rel.): 0 %

Segmentation in Y - Direction:

- Number of Segments: 1
- Gap (abs.): 0 mm
- Gap (rel.): 0 %

Rotation Angle: 0°

Prefix for the Segment Names: Segment

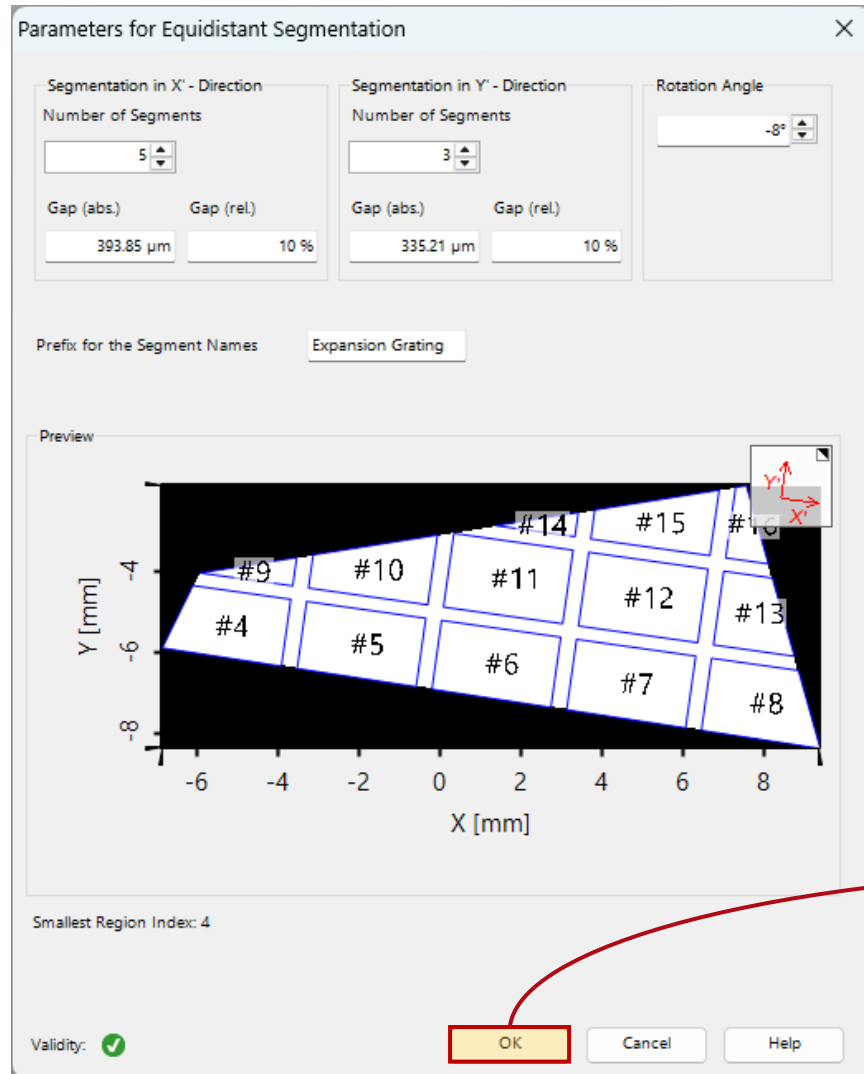
Preview: A graph showing the segmented region (labeled #4) on a coordinate system with X [mm] and Y [mm] axes. The X-axis ranges from -6 to 8, and the Y-axis ranges from -8 to -4. The region is a white polygon on a black background.

Smallest Region Index: 4

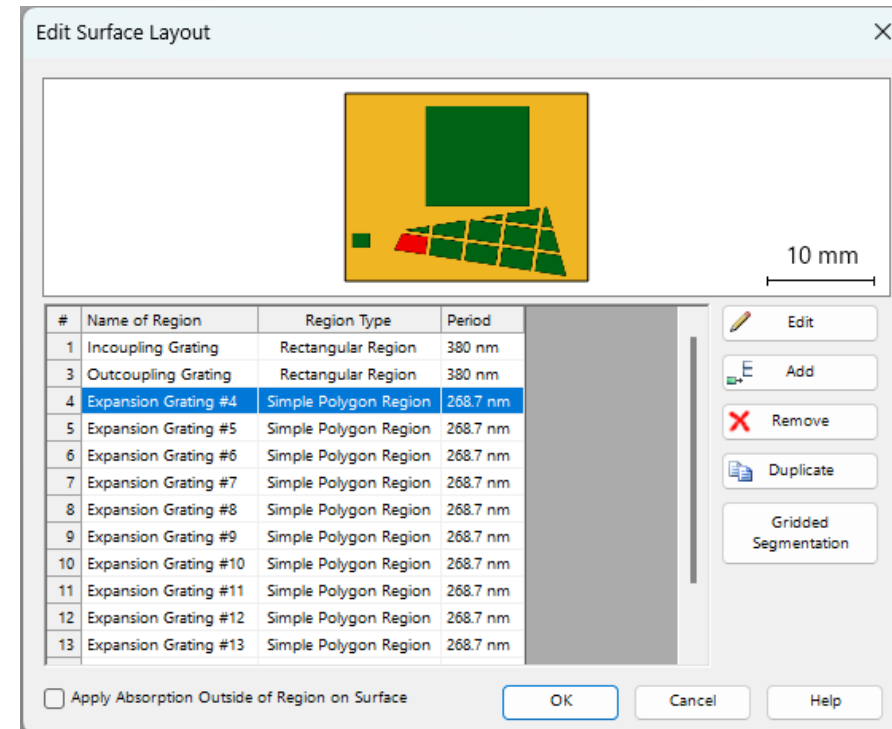
Validity: ✓

Buttons: OK, Cancel, Help

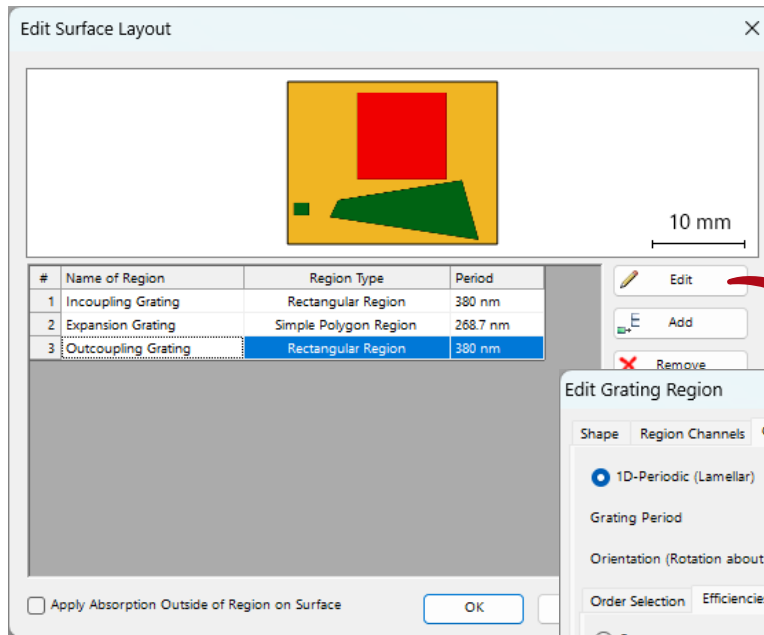
Segmentation of the Functional Grating



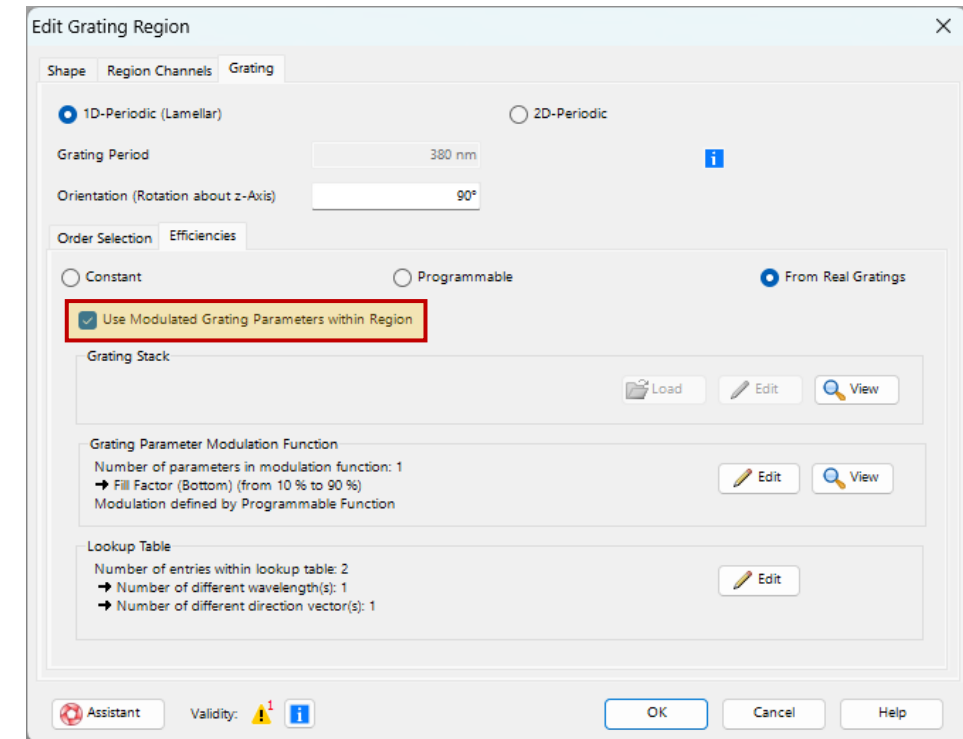
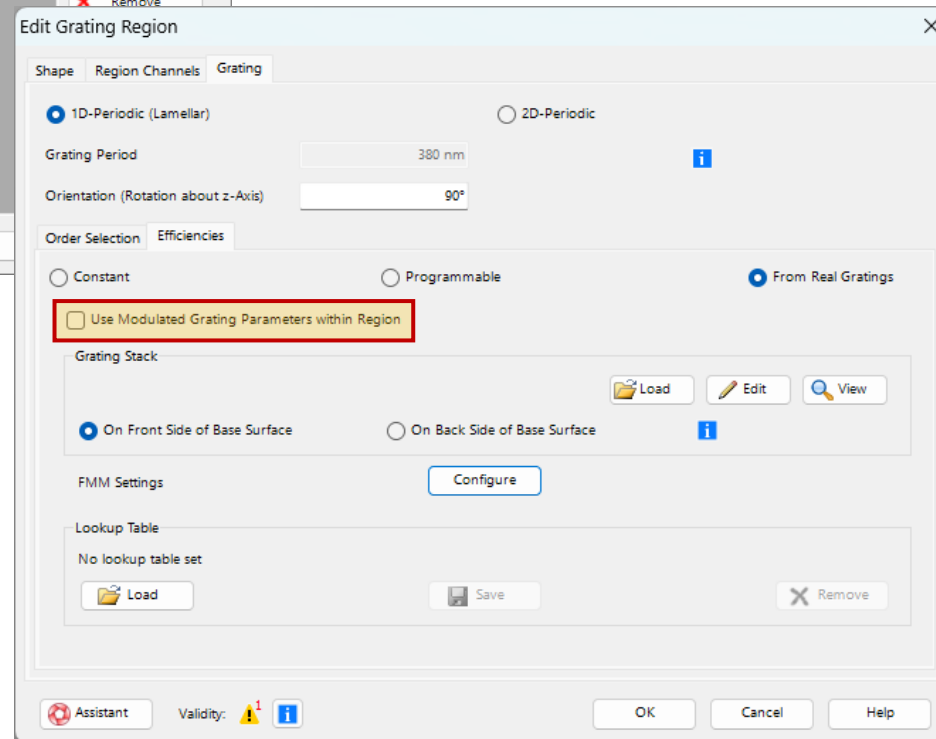
The shape of the gridded segmentation can be adjusted by modifying the *Number of Segments*, the *Gap* between them, and the *Rotation Angle*. Additionally, users can customize the segment name as needed.



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

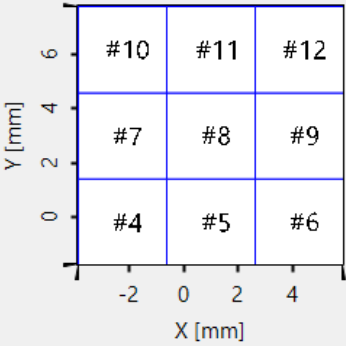
Segmentation in X - Direction
Number of Segments: 3
Gap (abs.): 0 mm, Gap (rel.): 0 %

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

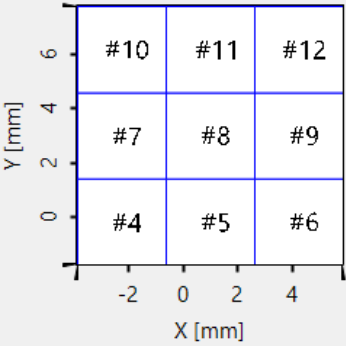
Parameters for Equidistant Segmentation

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

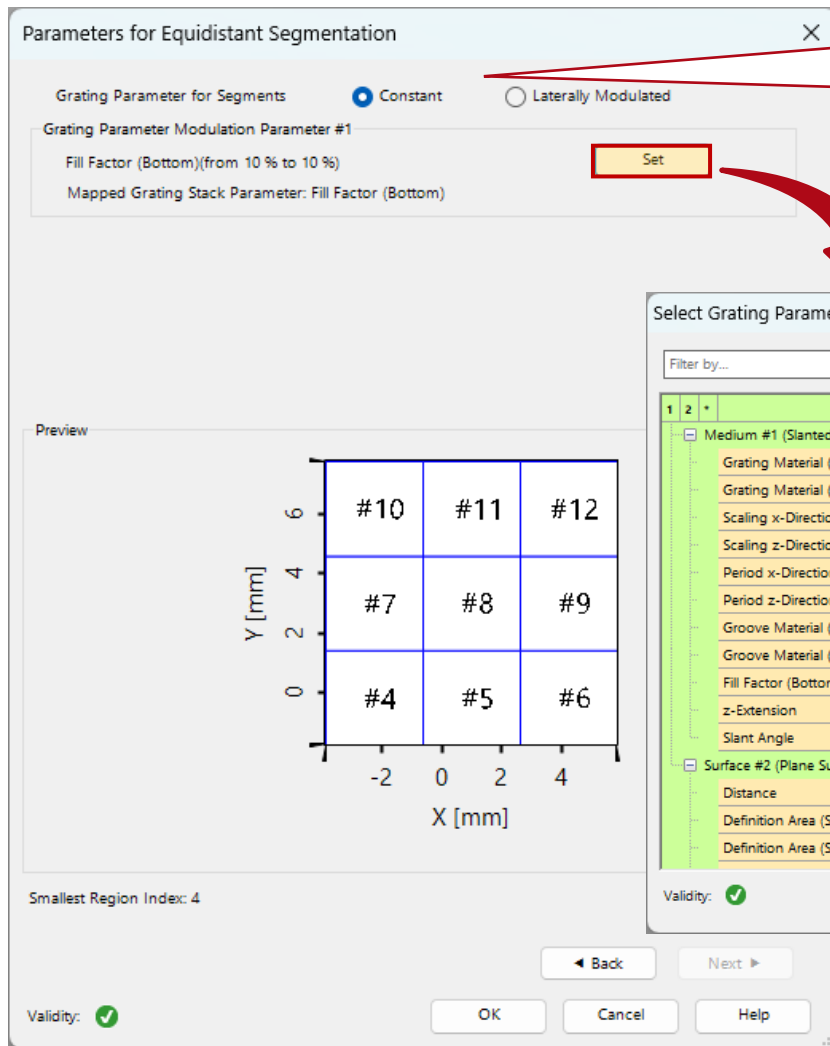
Parameters for Equidistant Segmentation

Set the Parameter Values per Segment:

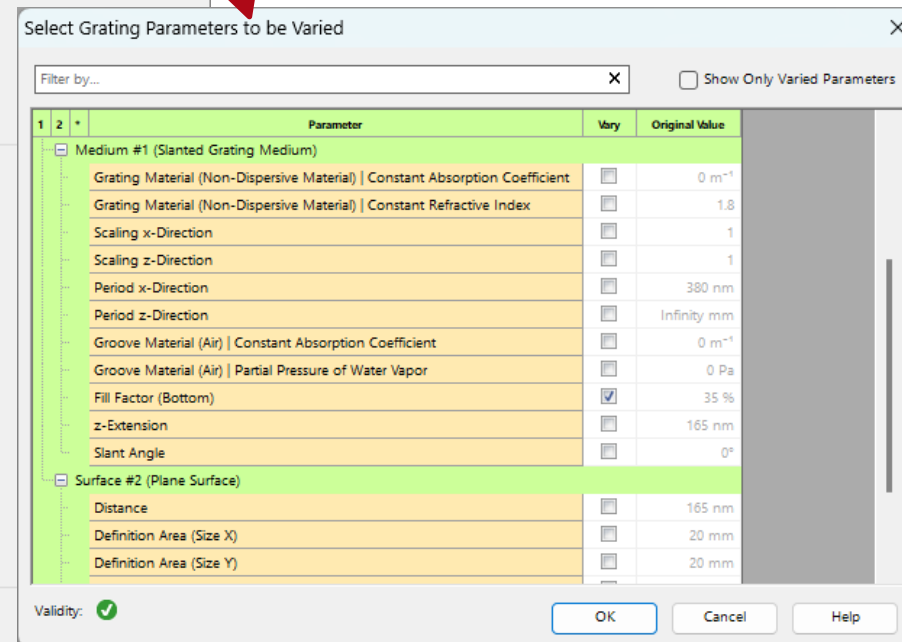
Parameter	Region #4	Region #5	Region #6	Region #7	Region #8	Region #9	Region #10	Region #11
Fill Factor (Bottom)	35 %	35 %	35 %	35 %	35 %	35 %	35 %	35 %

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 top-down view of the grating structure with a 10 mm scale bar. The 'Parameter Overview' window lists the parameters for each region, and the 'Profile Editing & Run' tab shows the parameter values for the selected region.

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

fill

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 %

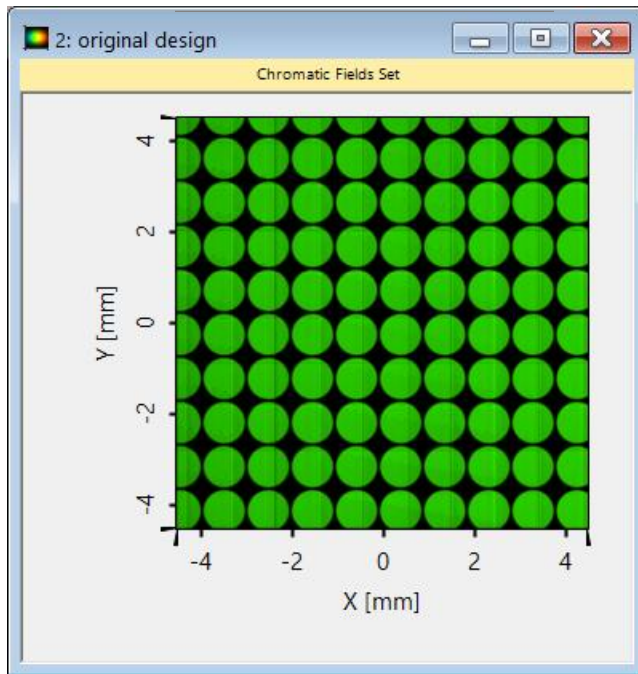
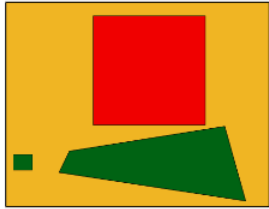
Profile Editing & Run

Profile Editor Parameter Overview Use Parameter Coupling Settings

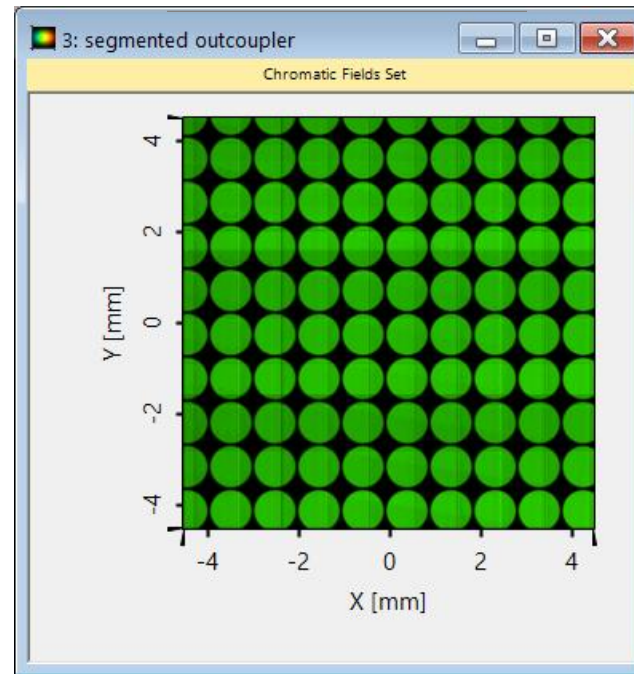
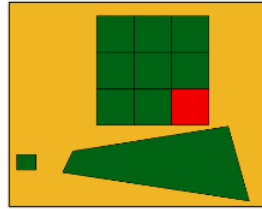
Validity: ☒ Show Minimum and Maximum Allowed Values OK Cancel Help

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.