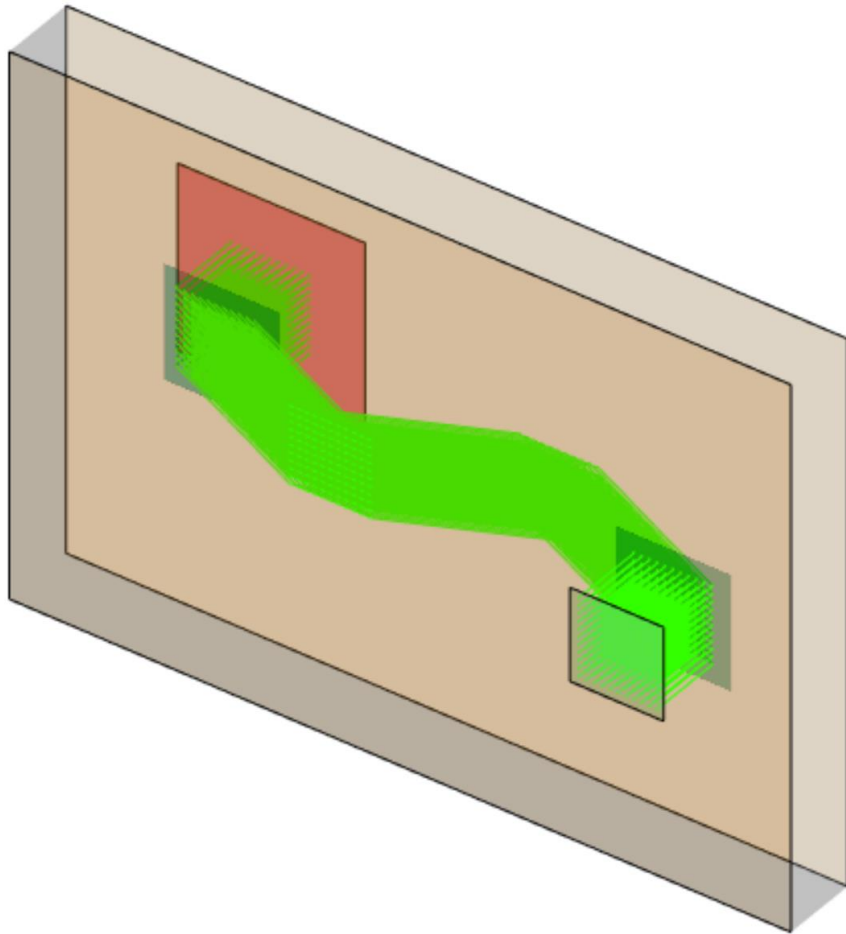


Construction of a Light Guide

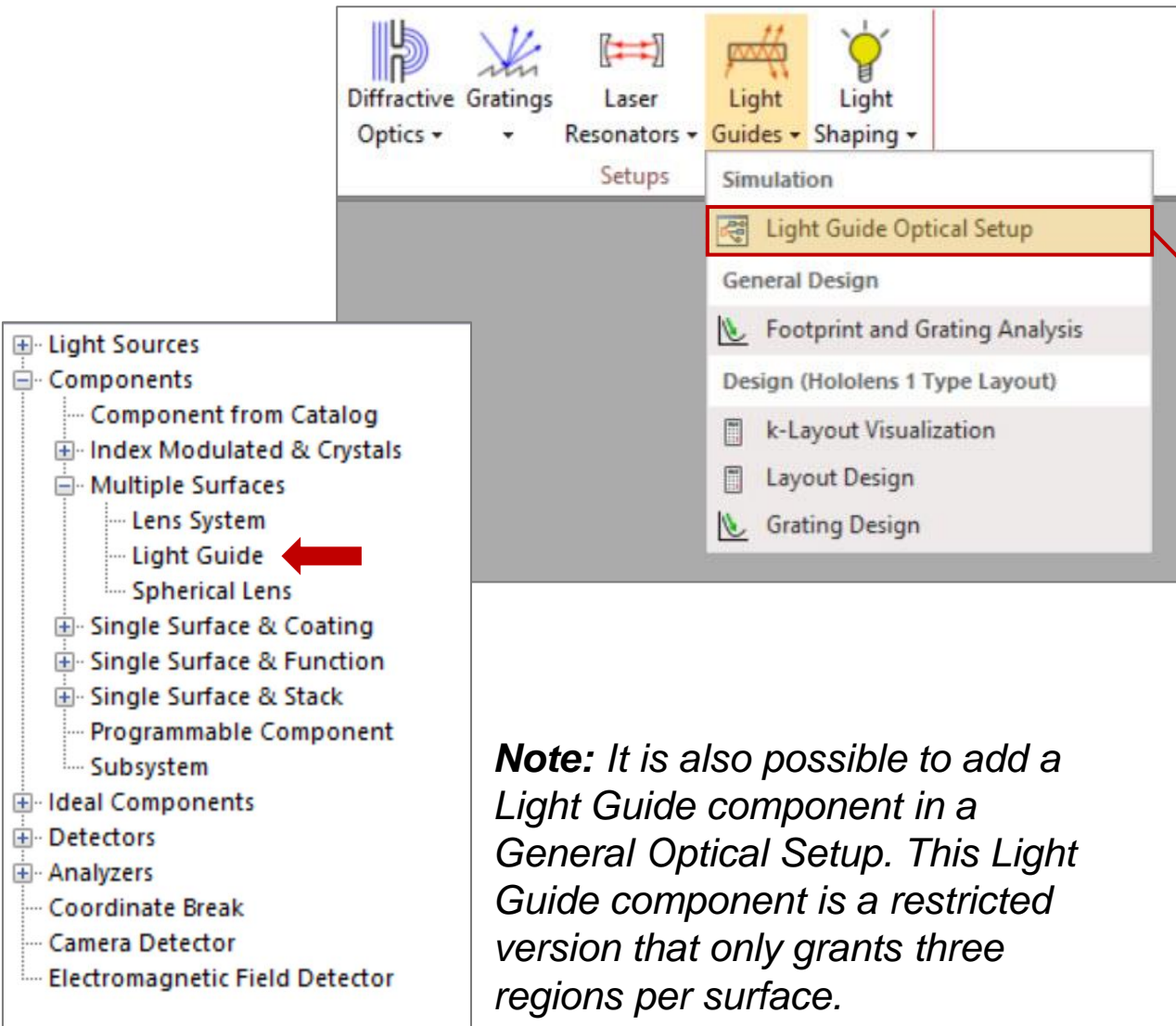
Abstract



New applications in the area of augmented and mixed reality (AR & MR) have drawn increased attention to light-guide systems with grating regions for in- and outcoupling, and pupil-expansion purposes.

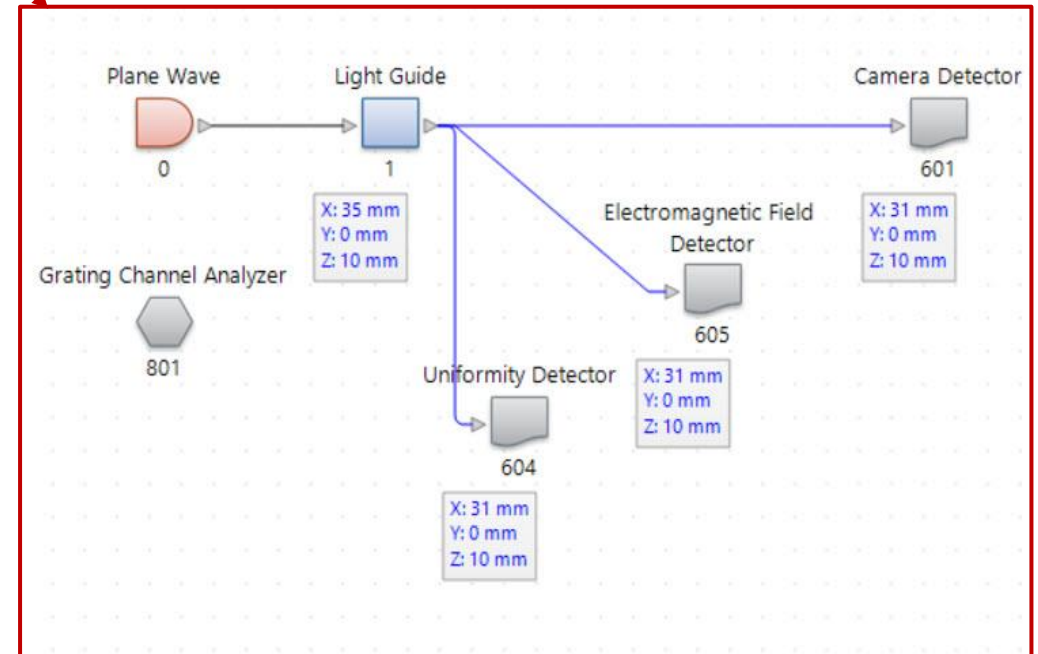
VirtualLab Fusion provides several powerful tools for the simulation and design of such systems, among them a light-guide component with flexible grating region configuration. The simulation then benefits from the “connecting field solvers” approach implemented in VirtualLab Fusion, as well as its effective non-sequential modeling technology. In this use case we present how to set up and configure the Light Guide component.

Initializing the Light Guide Component



The screenshot shows the software interface with the 'Light Guides' menu open. The menu items are: Simulation, Light Guide Optical Setup (highlighted with a red box), General Design, Footprint and Grating Analysis, Design (Hololens 1 Type Layout), k-Layout Visualization, Layout Design, and Grating Design. To the left, a component tree is visible with 'Light Guide' highlighted by a red arrow. The tree includes: Light Sources, Components (Component from Catalog, Index Modulated & Crystals, Multiple Surfaces (Lens System, Light Guide, Spherical Lens), Single Surface & Coating, Single Surface & Function, Single Surface & Stack, Programmable Component, Subsystem), Ideal Components, Detectors, and Analyzers (Coordinate Break, Camera Detector, Electromagnetic Field Detector).

In general, specialized *Light Guide Optical Setups* can be initialized through the *Setups* section of the *Start* menu tab. In this section, also various design and analysis tools for light guides can be found. Accessing all these tools requires a valid license for the Light Guide Toolbox

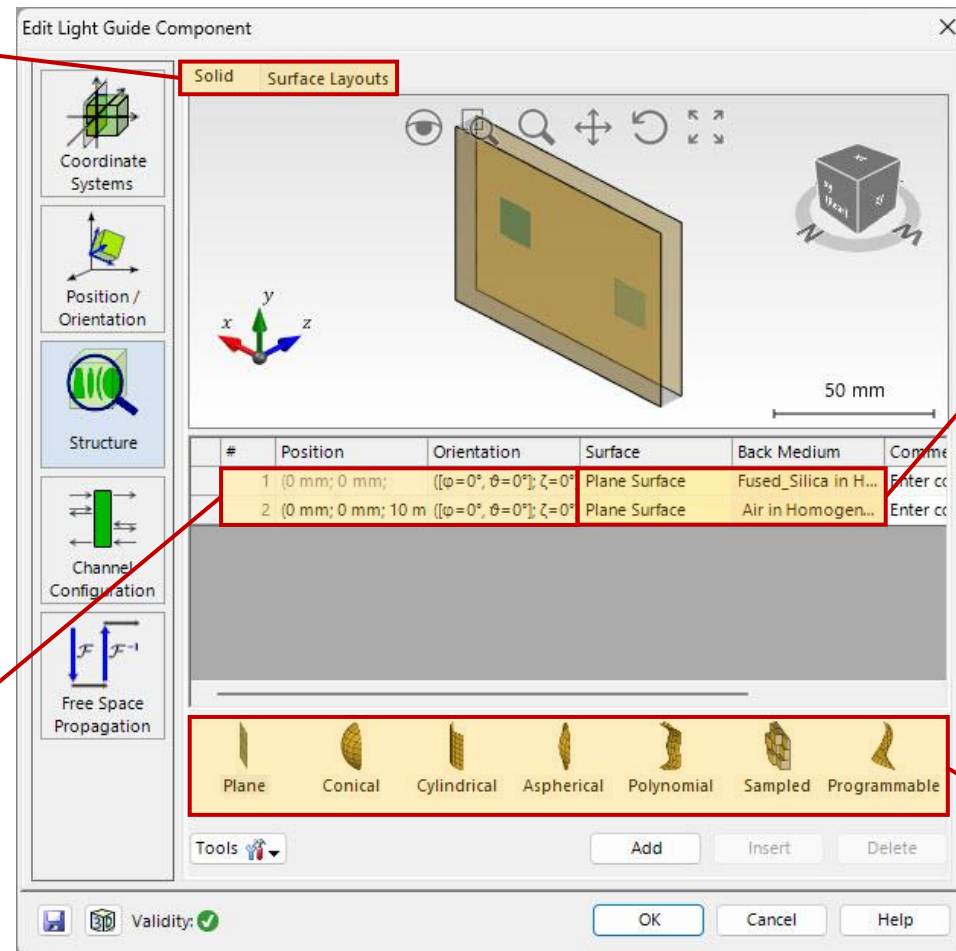


Note: It is also possible to add a *Light Guide* component in a *General Optical Setup*. This *Light Guide* component is a restricted version that only grants three regions per surface.

Configuration of the Light Guide Structure

The configuration dialog of the *Light Guide* component contains two tabs to set up the structure. In the *Solid* tab, options regarding the main structure are available. The *Surface Layouts* tab takes care of the regions defined on each surface which will exhibit special behavior different from that of the rest of the surface, such as regions containing coupling gratings.

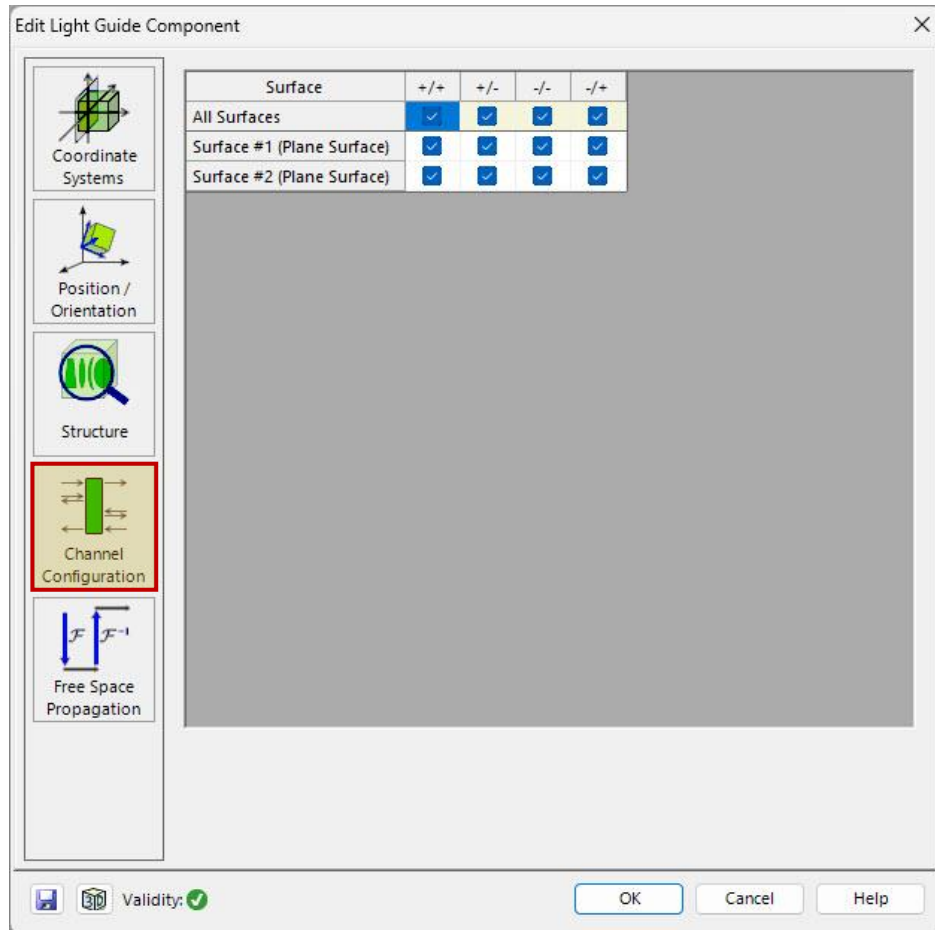
The position and orientation of all surfaces can be adjusted after they are added to the system.



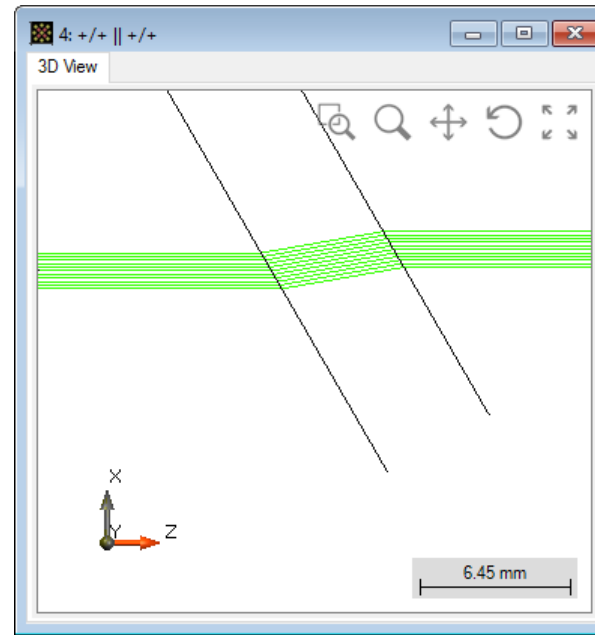
The main structure of the light guide can be defined as a sequence of surfaces and homogeneous media. The entries can be selected at will from the corresponding catalogs offered by default in VirtualLab Fusion, but customization through import and programming is also available.

Different types of surfaces can be added to the light guide.

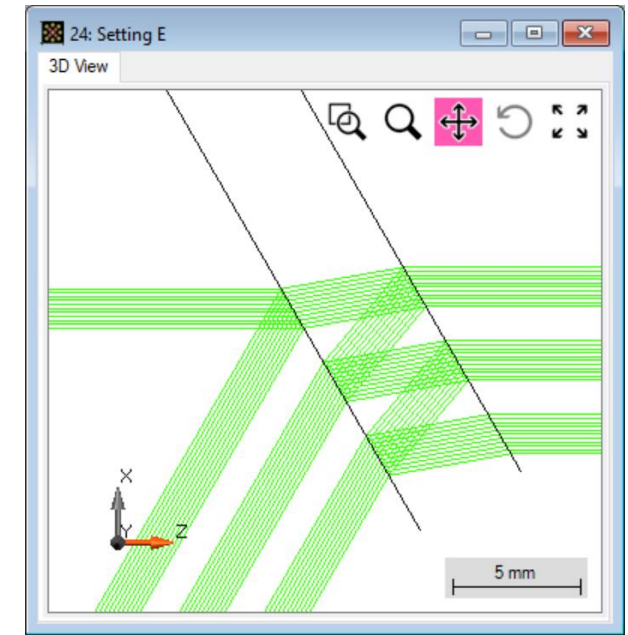
Configuration of the Light Guide Channels



The channel configuration allows the user to specify, per surface, which channels will be open for the simulation. The channels of the regions are handled separately. More information can be found in: [Channel Setting for Non-Sequential Tracing](#)



Surface	+/+	+/-	-/-	-/+
1st	×			
2nd	×			



Surface	+/+	+/-	-/-	-/+
1st	×	×	×	×
2nd	×	×	×	×

Adding Regions to a Light Guide Surface

The image illustrates the process of adding a region to a light guide surface through three windows:

- Edit Light Guide Component:** Shows a table of surfaces. The 'Edit Surface Layout' button for the first surface is highlighted with a red circle and arrow labeled '1'.
- Edit Surface Layout:** Shows a yellow square representing the surface layout. A red square represents the region being added. The 'Add Region' button is highlighted with a red circle and arrow labeled '2'.
- Edit Grating Region:** Shows a dialog for defining a rectangular region. The 'Region Name' is 'Square Region' and the 'Region Type' is 'Rectangular Region'. The 'Definition of Unrotated Rectangle' section includes fields for Center X (0 mm), Center Y (0 mm), Width (1 mm), and Height (1 mm). The 'Rotation Angle' is 0°. A 2D plot shows the region's position on an X-Y plane. The 'OK' button is highlighted with a red circle and arrow labeled '3'.

Surface Name	Edit	Surface layout containing 1 regions.
1 Plane Surface	Edit Surface Layout	Surface layout containing 1 regions.
2 Plane Surface	Edit Surface Layout	Surface layout containing 1 regions.

#	Name of Region	Region Type	Period
1	Incoupler	Rectangular Region	400 nm

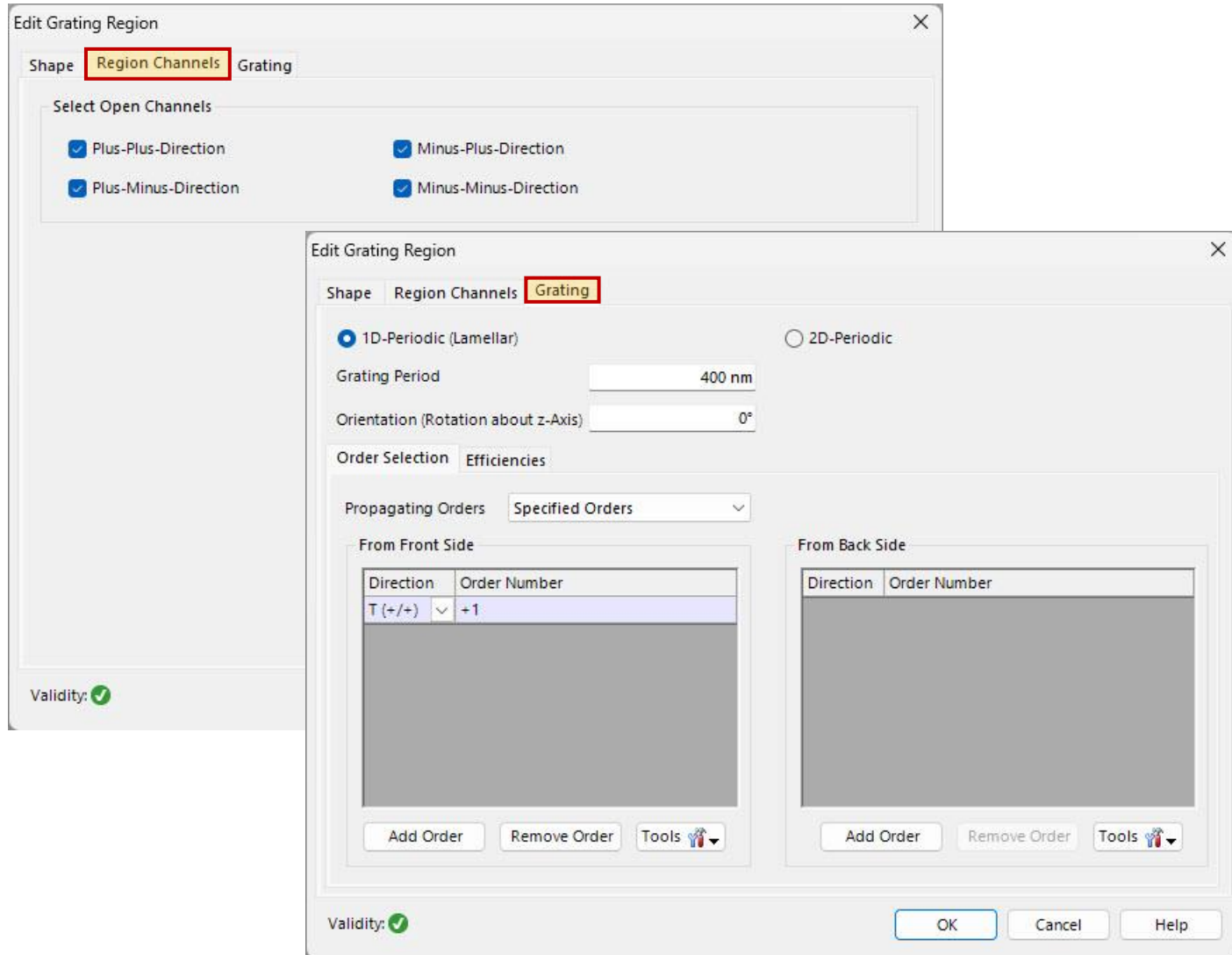
Region Name: Square Region
Region Type: Rectangular Region

Definition of Unrotated Rectangle
Center X: 0 mm, Center Y: 0 mm
Width: 1 mm, Height: 1 mm
 Keep Aspect Ratio
Validity:

Rotation Angle: 0°

Y [mm]: -0.25, 0, 0.25
X [mm]: -0.25, 0, 0.25

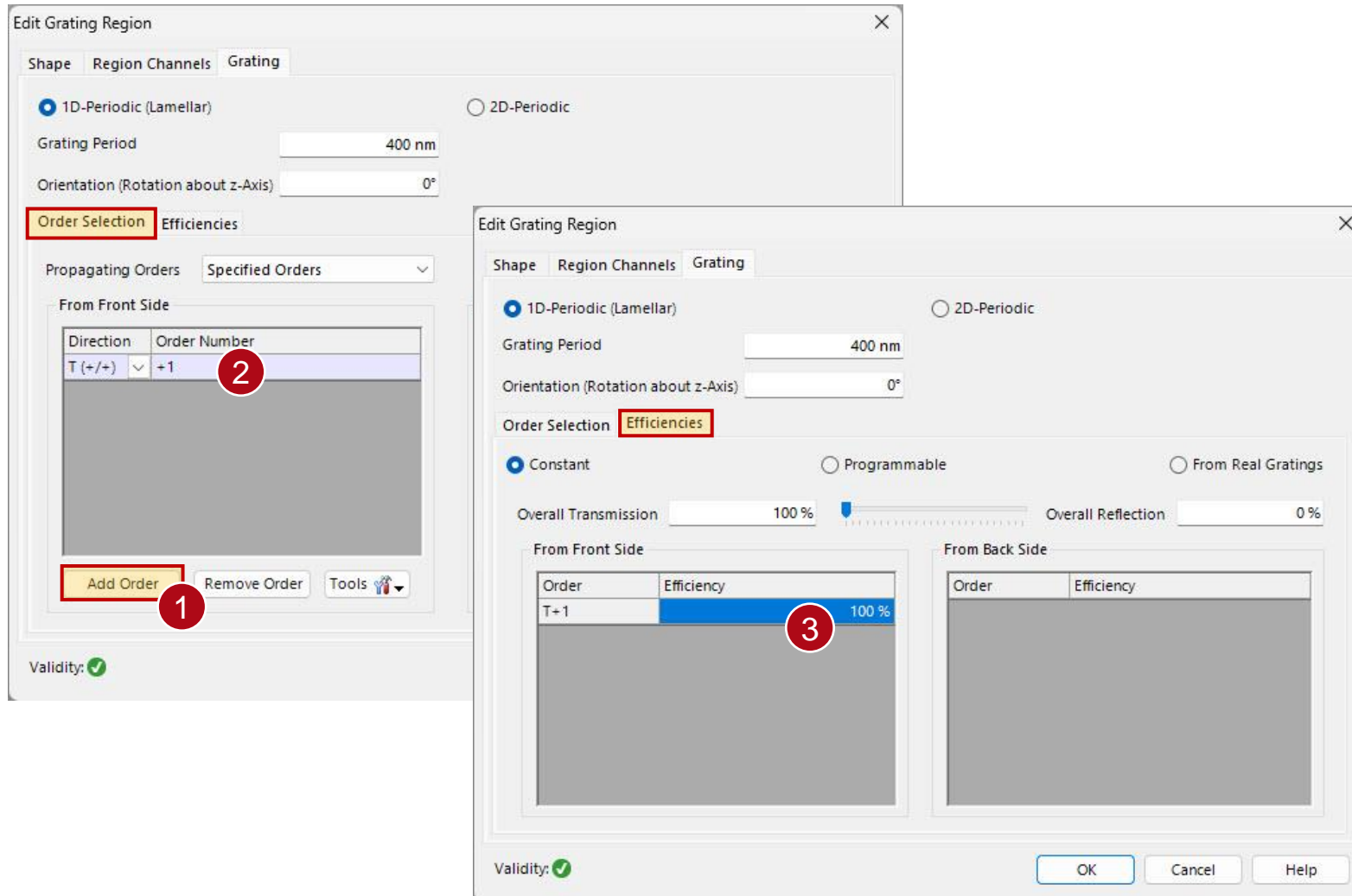
Add Grating to Region



In the *Grating* subsection the main characteristics of the grating, like *Grating Period* and *Orientation*, can be configured.

Similar to the *Light Guide Component* it is possible to define propagation channels in the *Region Channels* section for each individual grating region. The channels of the different regions defined on a light guide surface can differ, and therefore be configured independently, from the master channels of the surrounding surface.

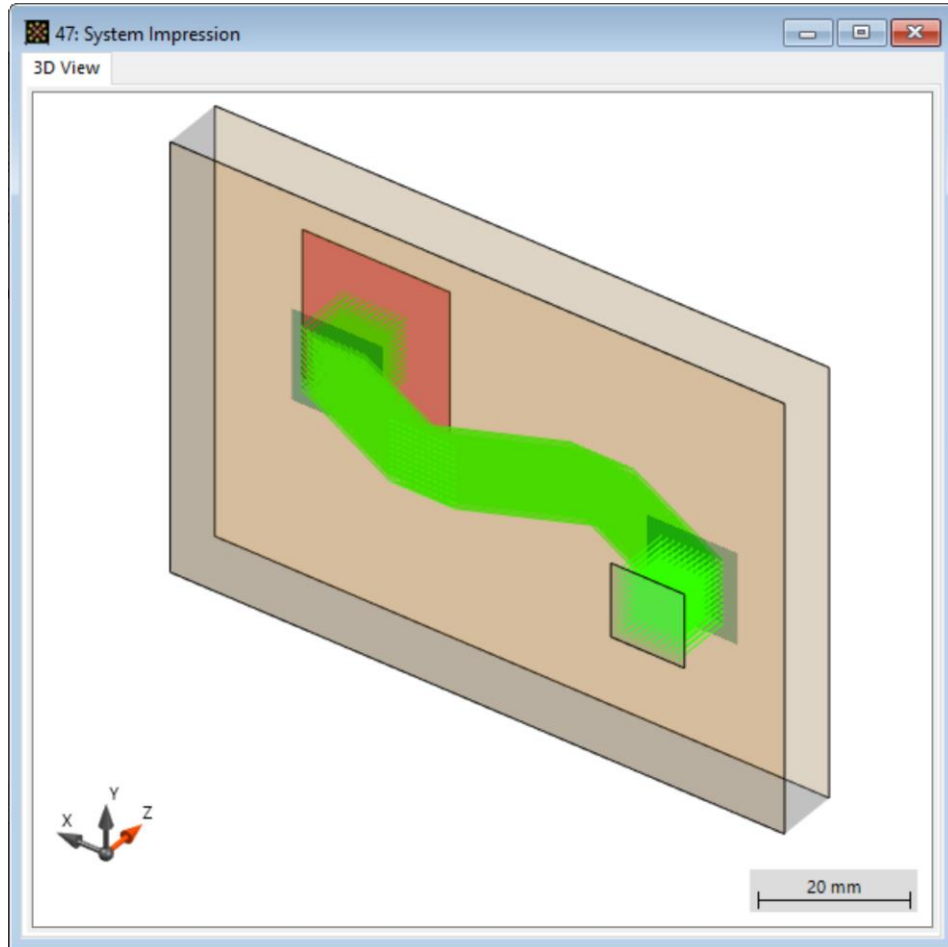
Configure Grating Orders



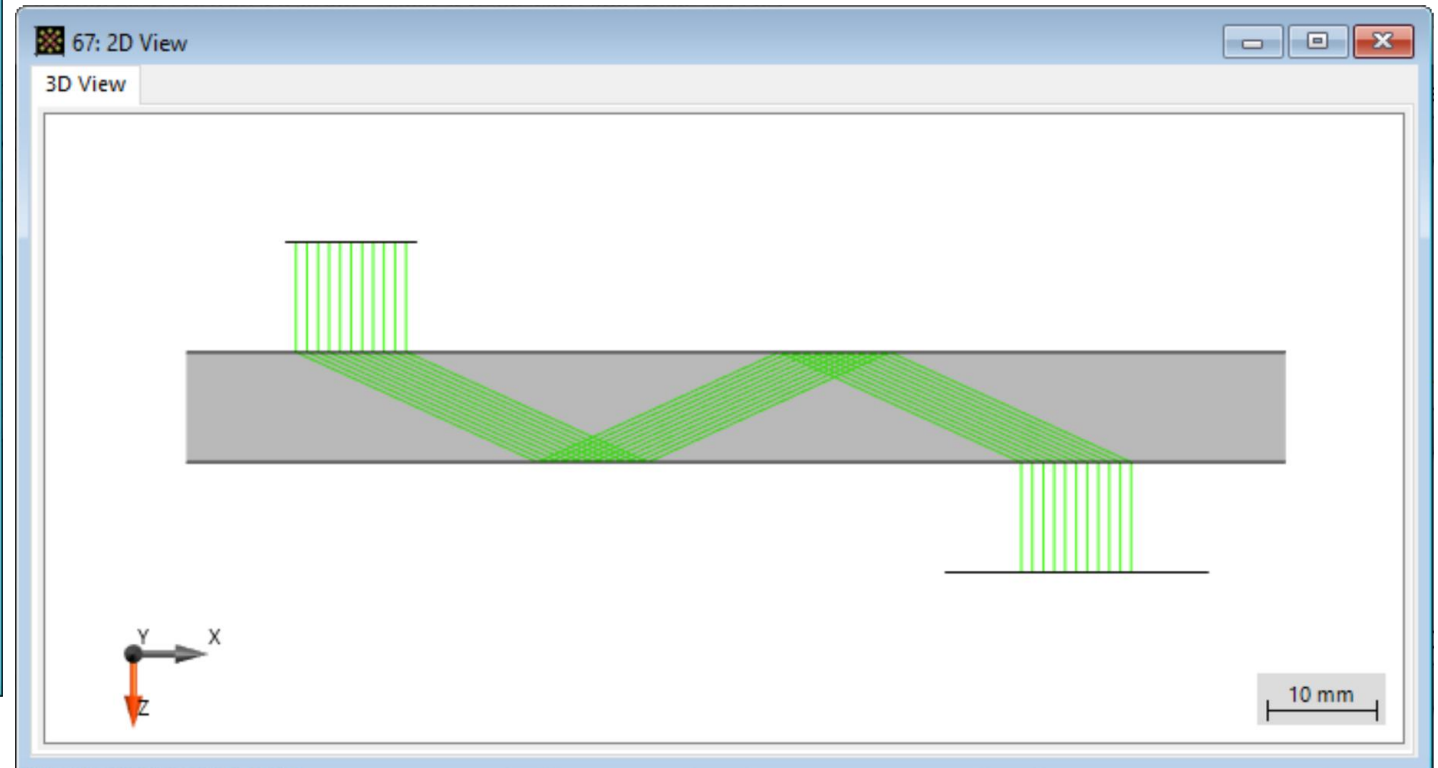
In order to add specific diffraction orders to the list of those to be considered in the simulation, use *Add Order* in the *Order Selection* tab of the *Grating* subsection.

Then specify the desired order in the corresponding table. In the *Efficiencies* tab it is possible to either enter an efficiency value manually, or to calculate the actual electromagnetic grating response from the real grating structure.

3D Ray Tracing System View

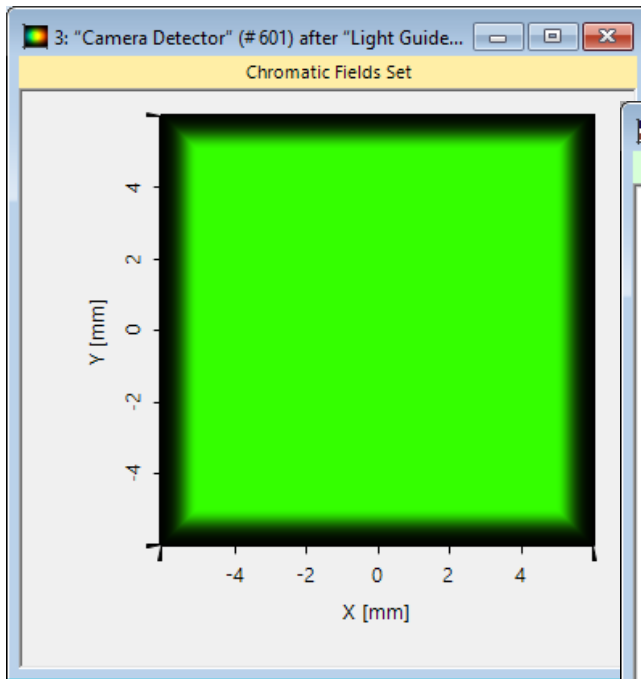


The *Rays in System* simulation in VirtualLab Fusion provides a simple visualization of the path(s) the light takes in a light guide.

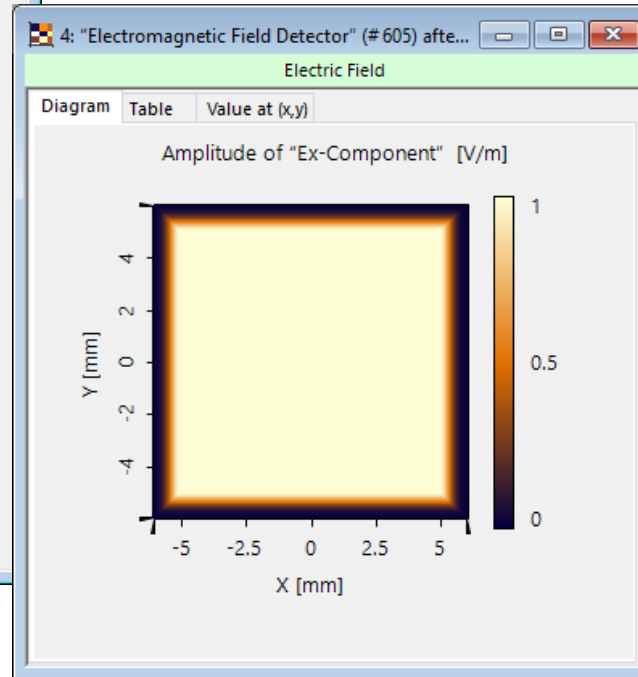


Field Tracing Results

In addition, the *Light Guide* component and the *Light Guide Optical System* also work with Field Tracing and its various detectors to provide more information about the system. These simulations can also include crucial effects like polarization, coherence and diffraction from apertures, exemplarily shown below.



energy density
outcoupled
from lightguide



amplitude of Ex
component outcoupled
from lightguide

Sub - Detector	Result
Value for Pupil around (-42.80762683 μm ; 4.006799412E-29 mm)	1 (V/m) ²
Minimum	1 (V/m) ²
Maximum	1 (V/m) ²
Uniformity Error	0 %
Arithmetic Mean	1 (V/m) ²
Standard Deviation	0 (V/m) ²

investigation of lateral
uniformity, e.g. in eye box

Document Information

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version	1.2
edition	VirtualLab Fusion Advanced
software version	2023.1 (Build 1.556)
category	Feature Use Case
further reading	<ul style="list-style-type: none">• <u>Modeling of a “HoloLens 1”-Type Layout with Light Guide Component</u>• <u>Channel Resolution Accuracy Setting of Non-Sequential Field Tracing</u>• <u>Channel Setting for Non-Sequential Tracing</u>