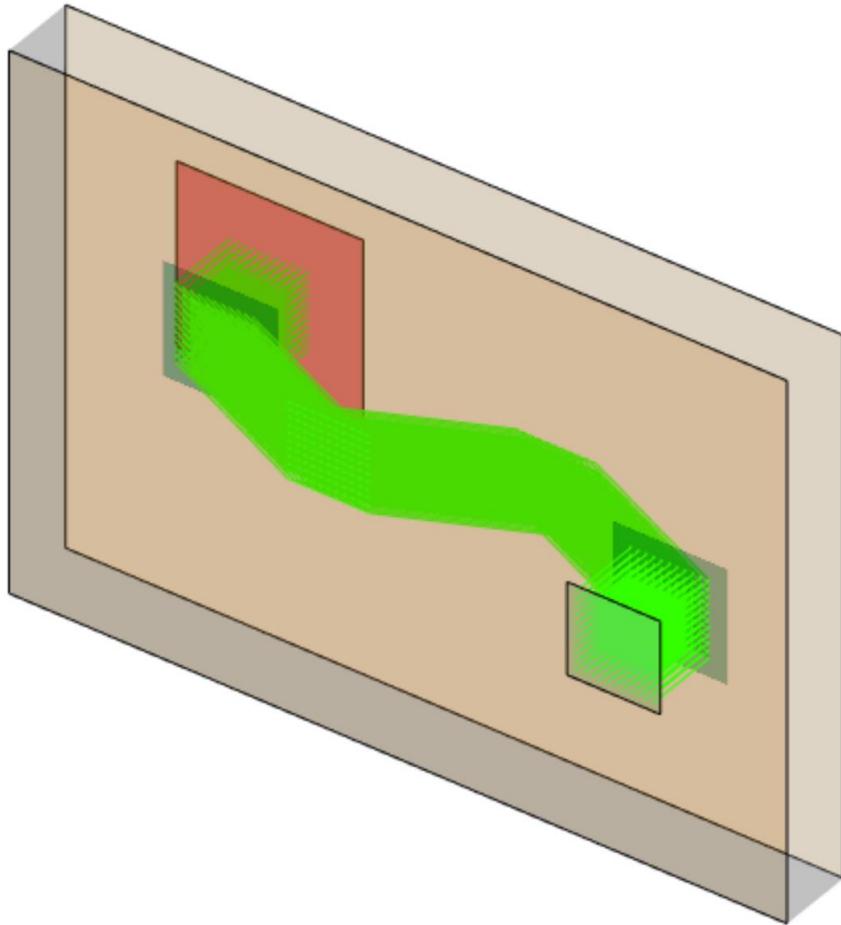


Construction of a Light Guide

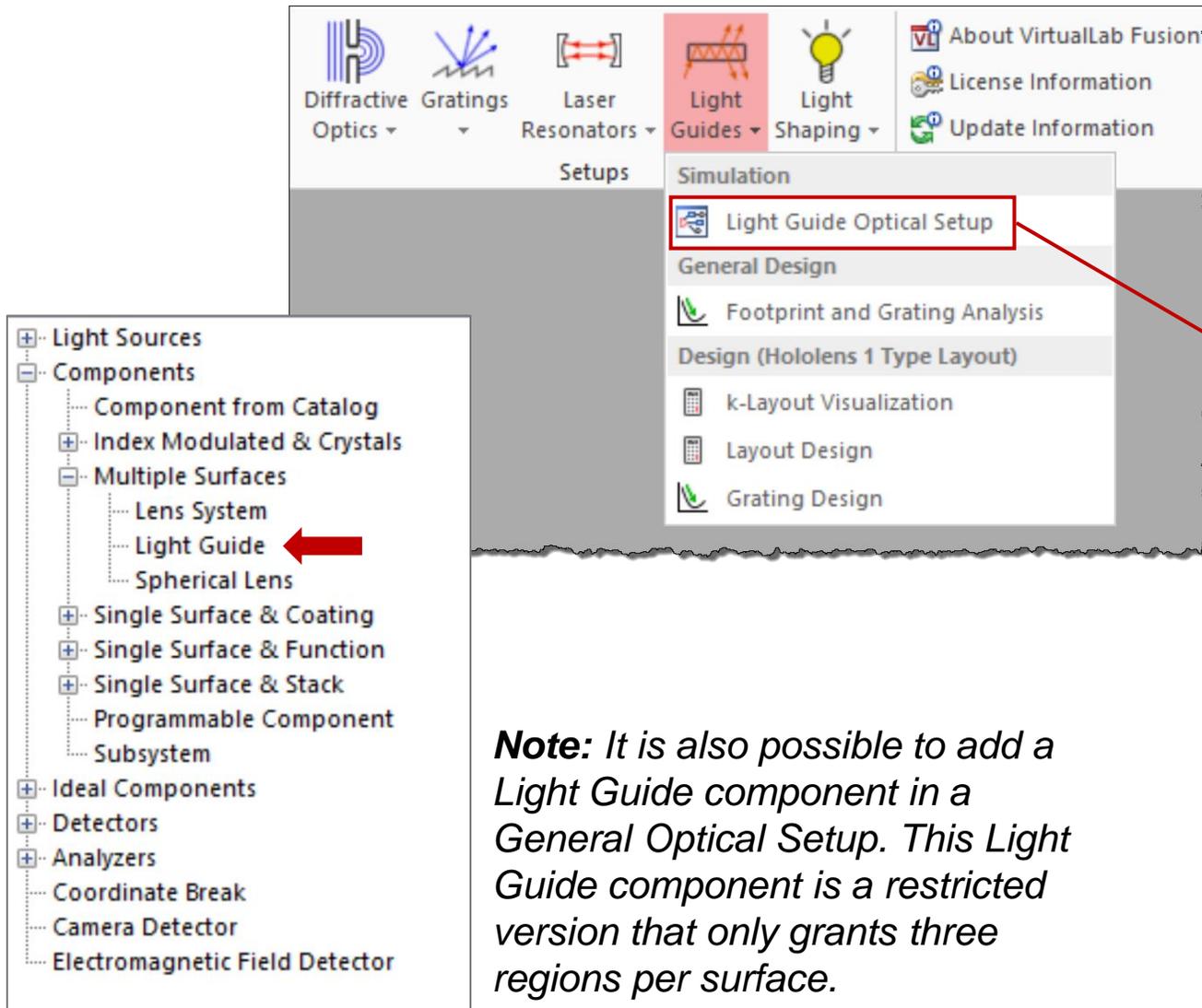
Abstract



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.

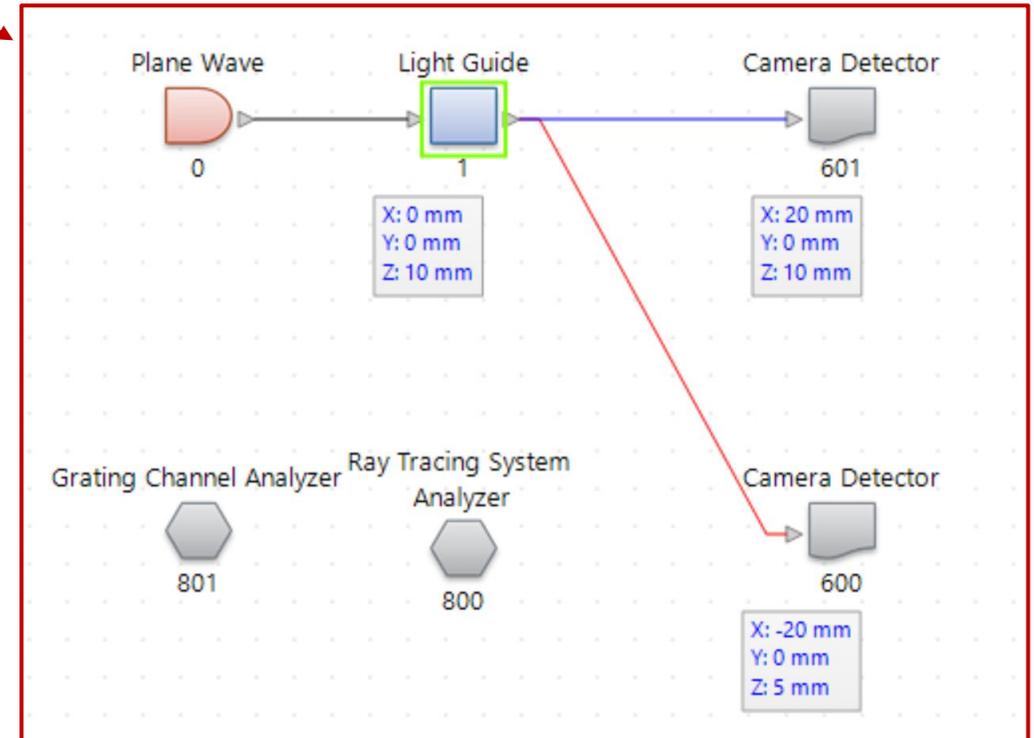
Initializing the Light Guide Component



The screenshot shows the 'Light Guides' menu in the VirtualLab Fusion software. The menu is open, displaying options such as 'Light Guide Optical Setup', 'General Design', 'Footprint and Grating Analysis', 'Design (Hololens 1 Type Layout)', 'k-Layout Visualization', 'Layout Design', and 'Grating Design'. A red arrow points from the 'Light Guide Optical Setup' option to the diagram on the right. On the left, a component tree is visible, with 'Light Guide' highlighted under the 'Components' section.

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.

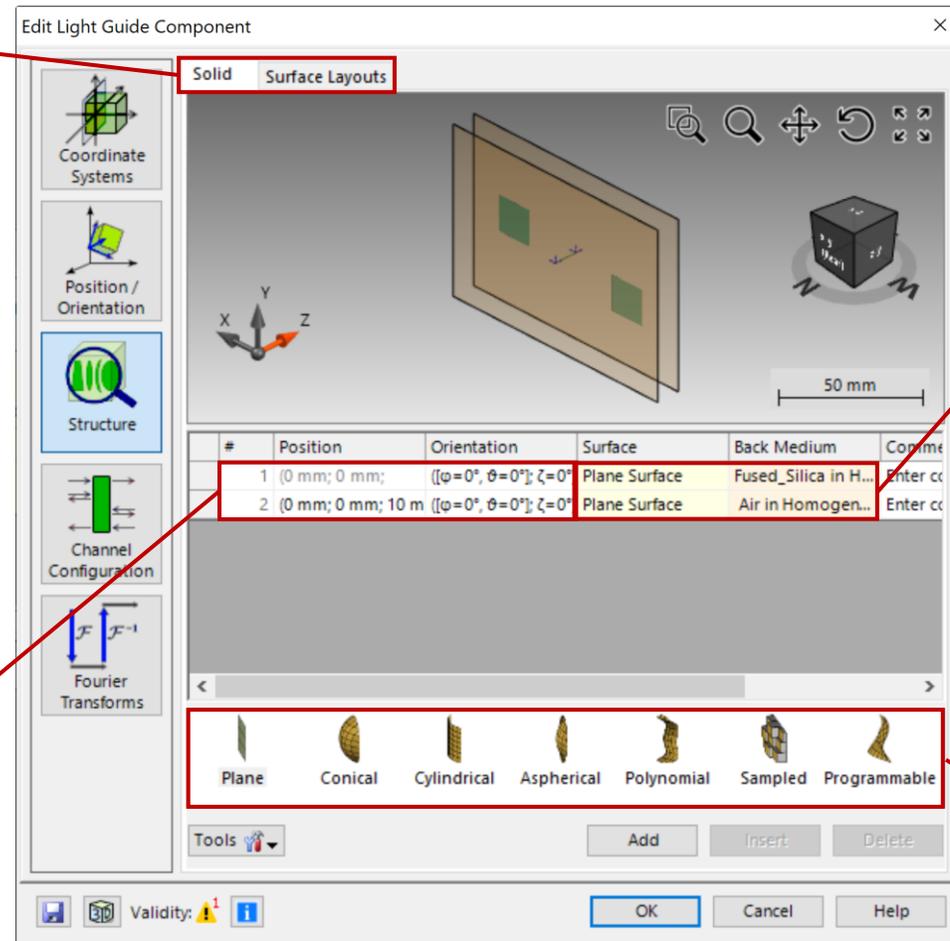
In general, specialized *Light Guide Optical Setups* can be initialized through the *Setups* section of the *Start* menu tab. In this section, also various design and analysis tools for light guides can be found. Accessing all these tools requires a valid license for the Light Guide Toolbox



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.

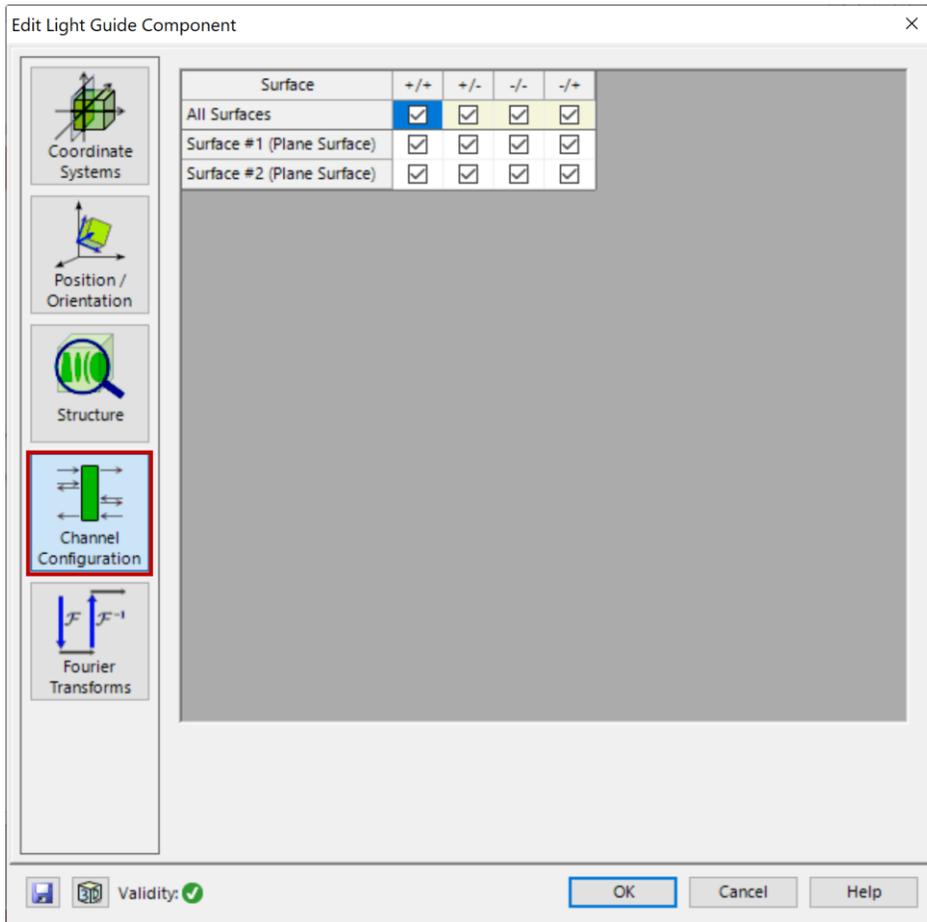
The position and orientation of all surfaces can be adjusted after they are added to the system.



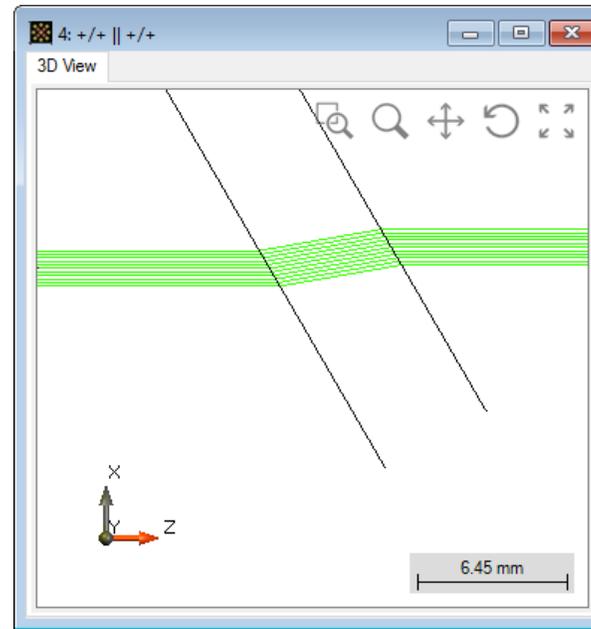
The main structure of the light guide can be defined as a sequence of surfaces and homogeneous media. The entries can be selected at will from the corresponding catalogs offered by default in VirtualLab Fusion, but customization through import and programming is also available.

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

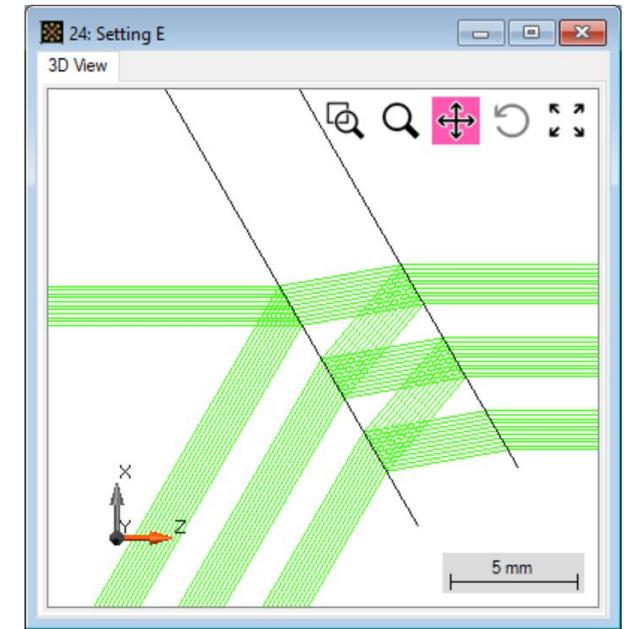
Configuration of the Light Guide Channels



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 screenshot illustrates the process of adding a region to a light guide surface. It consists of three overlapping windows:

- Edit Light Guide Component:** The 'Structure' icon in the left sidebar is highlighted with a red box and a red circle labeled '1'. The 'Surface Layouts' tab is active, showing a table with two entries.
- Edit Surface Layout:** This window shows a table with one region defined. A red box highlights the 'Add Region' button, with a red circle labeled '2' next to it.
- Edit Grating Region:** This window shows the configuration for a square region. A red box highlights the 'OK' button, with a red circle labeled '3' next to it.

Table 1: Edit Surface Layout

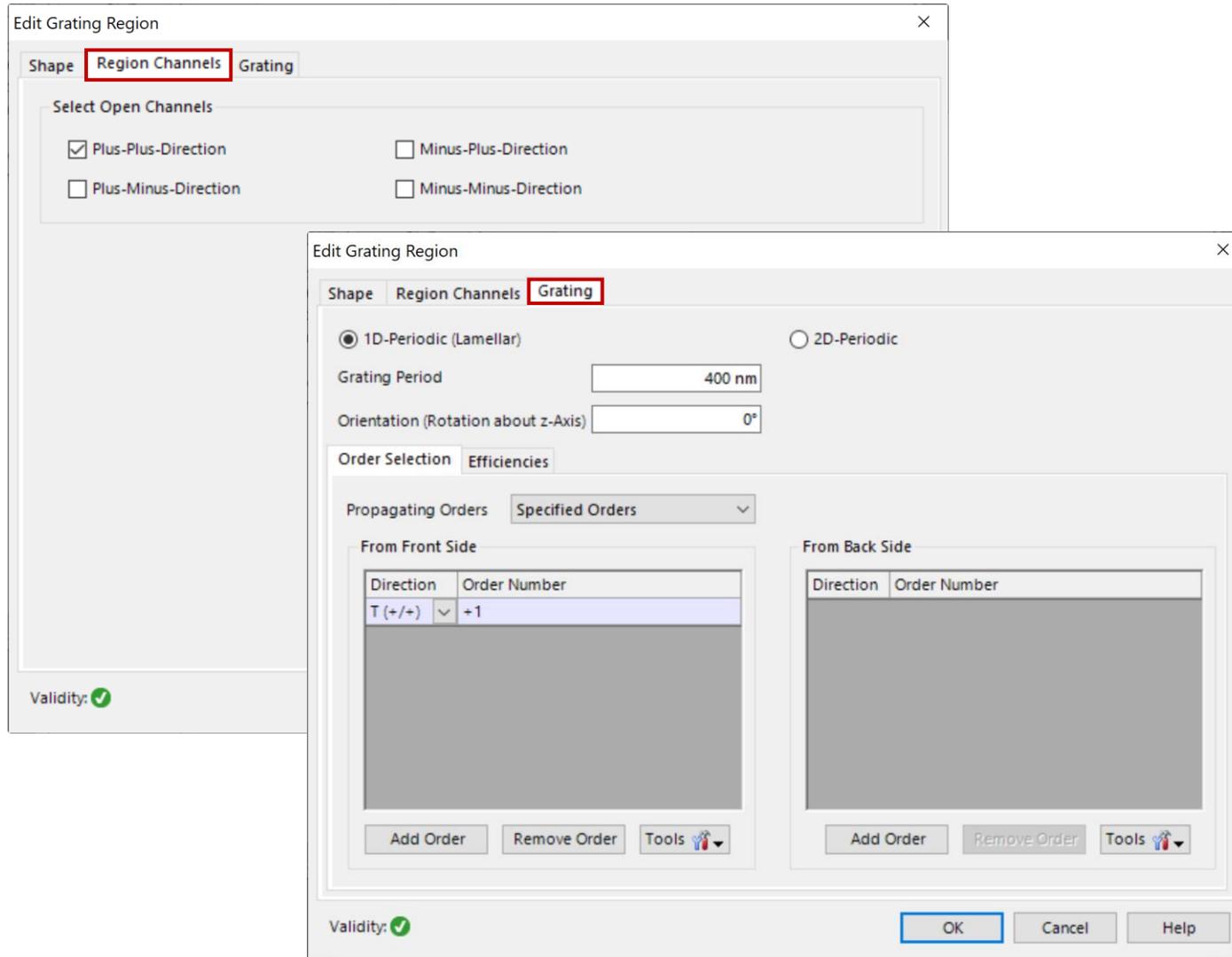
#	Name of Region	Region Type	Period
1	Square Region	Rectangular Region	400 nm

Table 2: Edit Grating Region (Shape Tab)

Region Name	Square Region
Region Type	Rectangular Region
Center X	0 mm
Center Y	0 mm
Width	1 mm
Height	1 mm
Rotation Angle	0°

Figure 1: Grating Region Plot

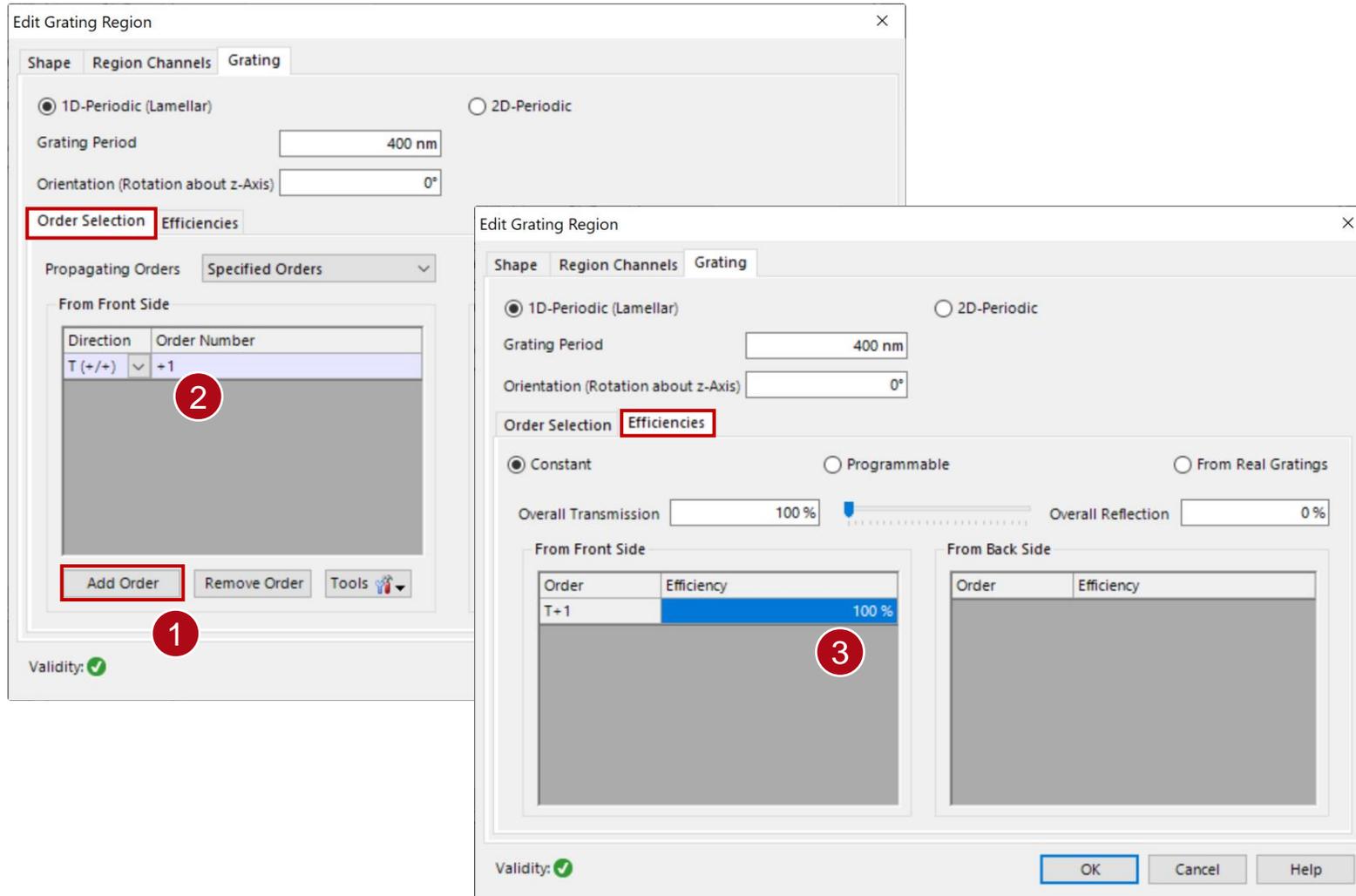
Add Grating to Region



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.

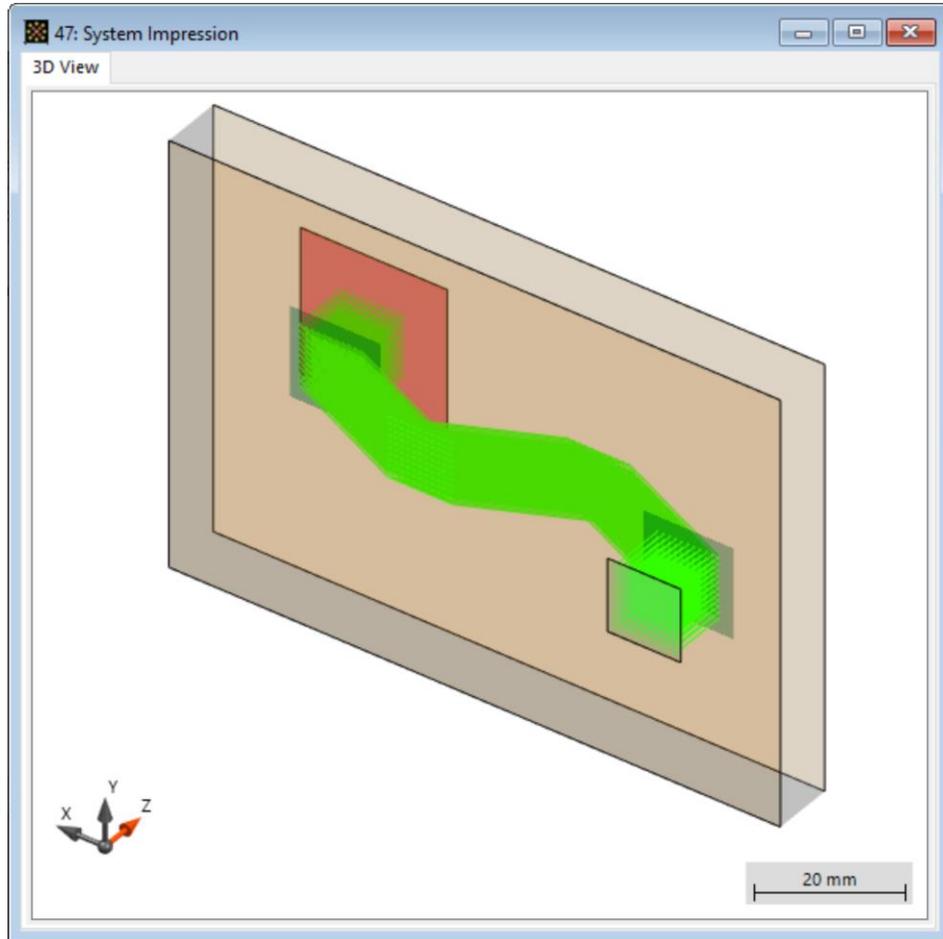
Configure Grating Orders



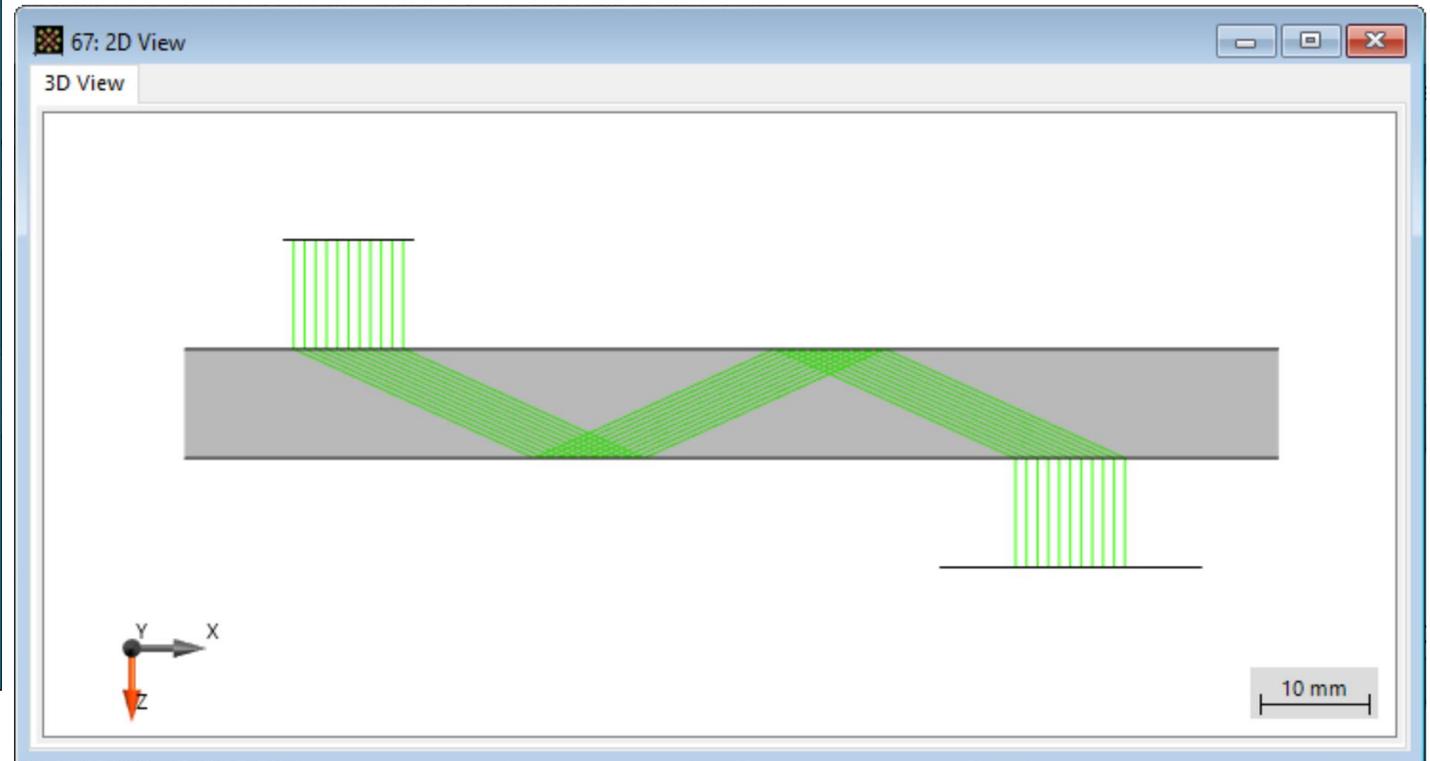
In order to add specific diffraction orders to the list of those to be considered in the simulation, use *Add Order* in the *Order Selection* tab of the *Grating* subsection.

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

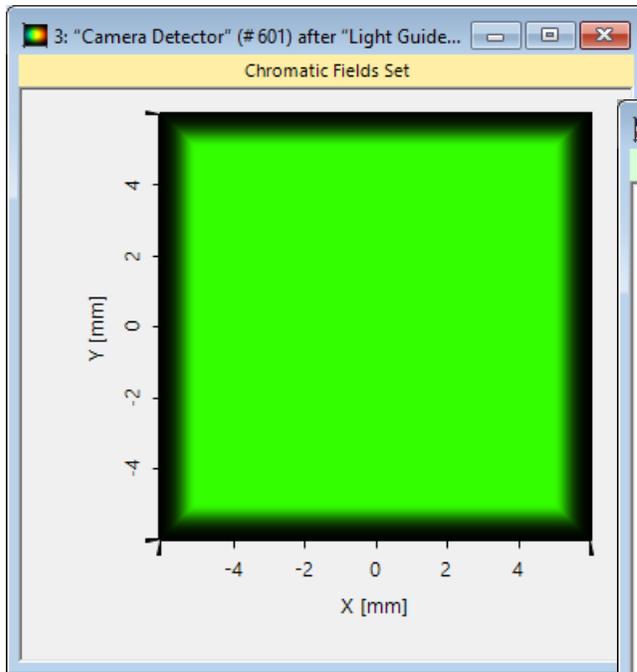


The *Rays in System* simulation in VirtualLab Fusion provides a simple visualization of the path(s) the light takes in a light guide.

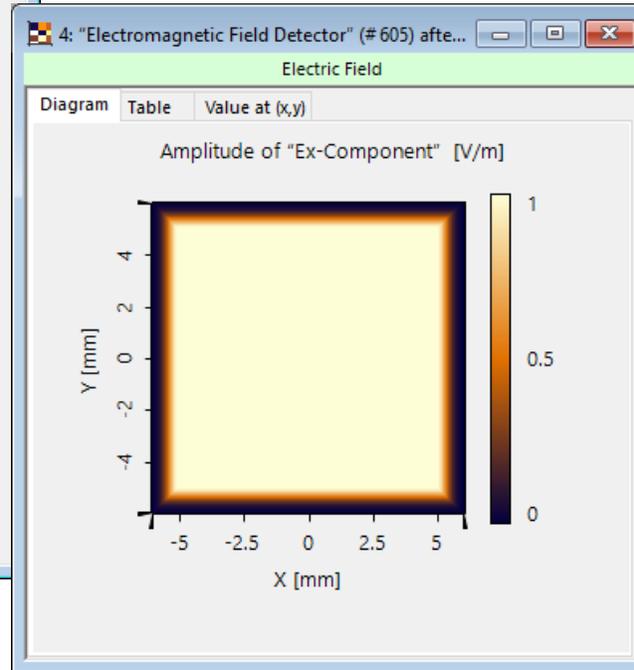


Field Tracing Results

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

title	Construction of a Light Guide
document code	LIG.0001
version	1.0
edition	VirtualLab Fusion Advanced
software version	2021.1 (Build 1.180)
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>

Presearch

LIG.0001, lightguide, light guide, light-guide, wave guide, waveguide, waveguide, region, channel, non-sequential, grating, TIR

Short Abstract

Light guides with coupling gratings can be set up in VirtualLab Fusion using the Light Guide component and its flexible region definition.

Marketing Picture

