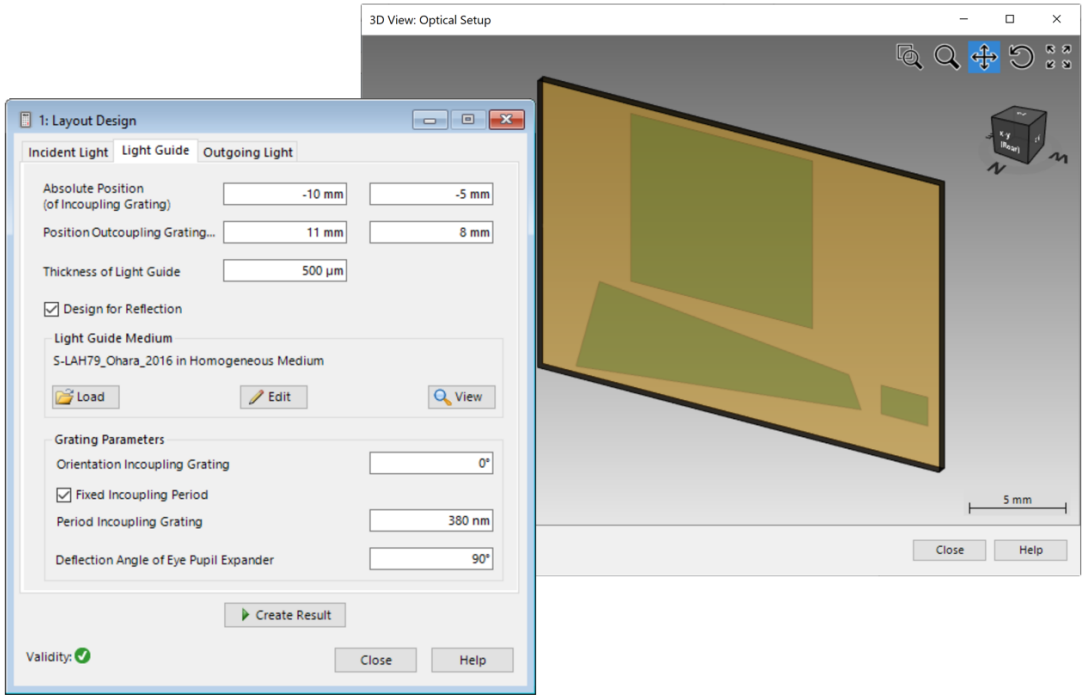
Light Guide Layout Design Tool

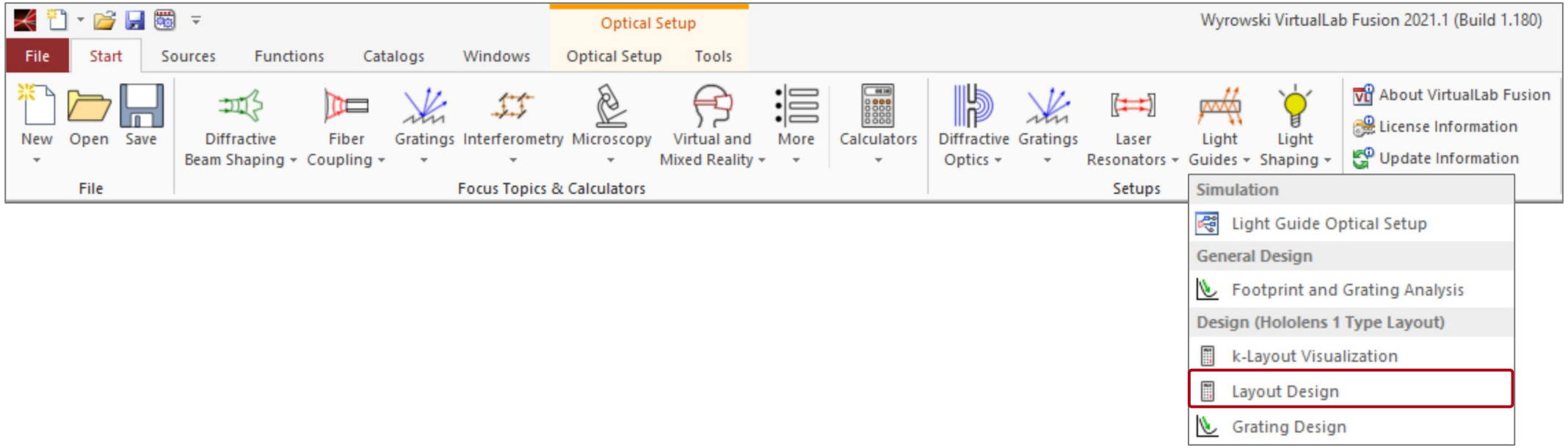
Abstract



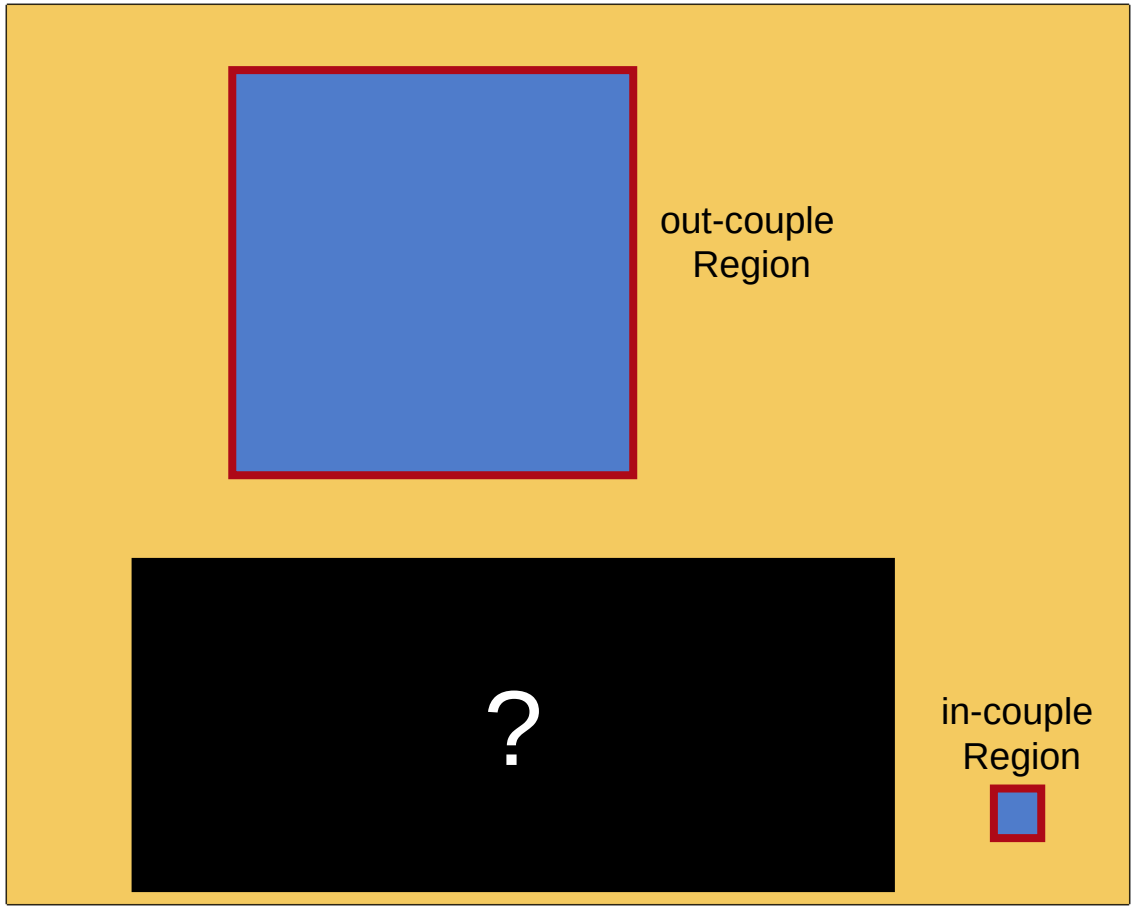
With the advances in augmented and mixed reality (AR & MR) technology, lightguide devices have become the object of increasing interest. To help the optical engineer with the design of such systems, VirtualLab Fusion offers several systematic design tools that break down the task into a controlled, step-by-step process. In this use case we demonstrate the capabilities of the Layout Design tool to automatically generate “Hololens 1”-type (1D-1D pupil expansion with linear gratings) systems according to the specifications of the user.

Open the AR & VR Layout Design Calculator

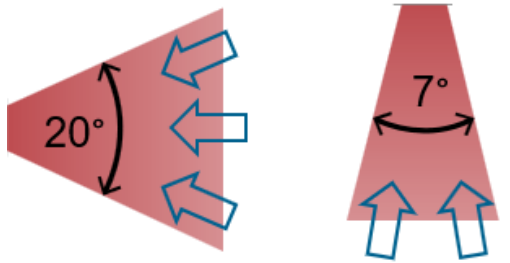
- The *Layout Design* tool is a special calculator in the *Light Guide Toolbox Gold Edition*.
- It is initialized in the *Light Guides* section within the *Start* ribbon of the main window.



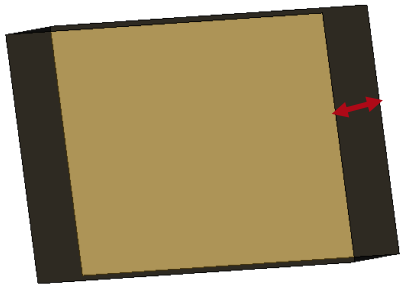
Layout Design – Setup Parameters



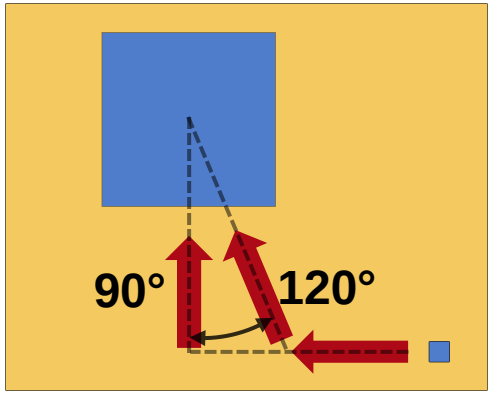
- Field of view range (FOV)



- Position & orientation of in- and outcoupling region



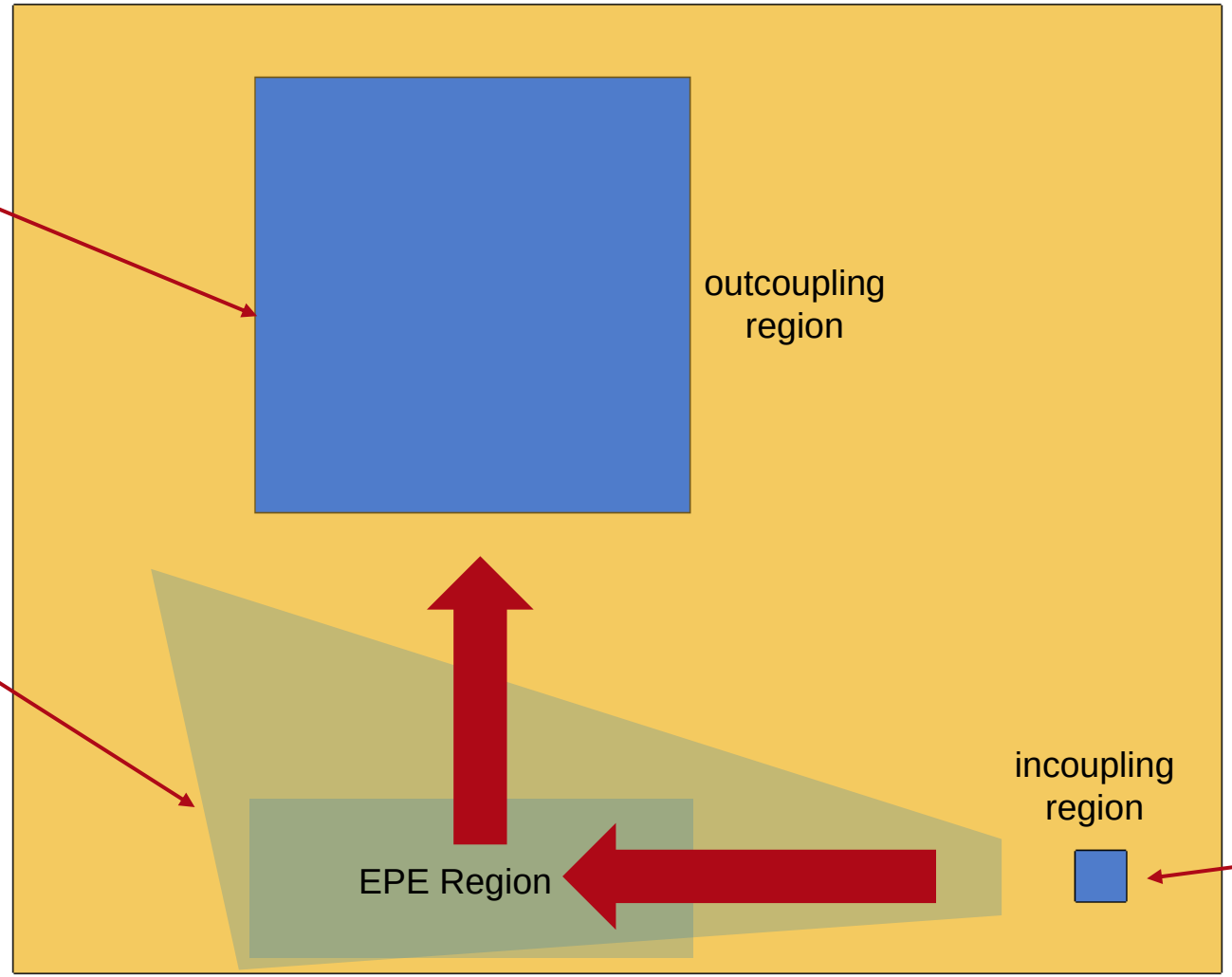
- Thickness of waveguide
- Eye Pupil Expansion (EPE) deflection angle



Layout Design – Calculated Parameters

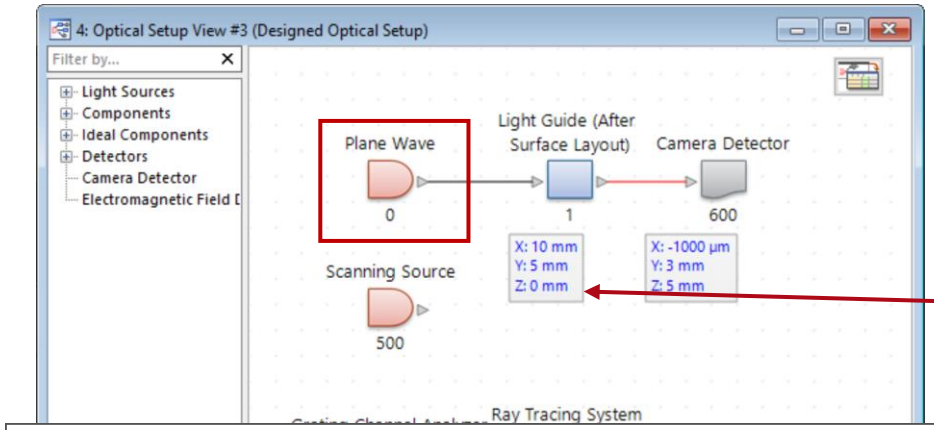
outcoupling region
- grating period
- grating orientation
- lateral extension

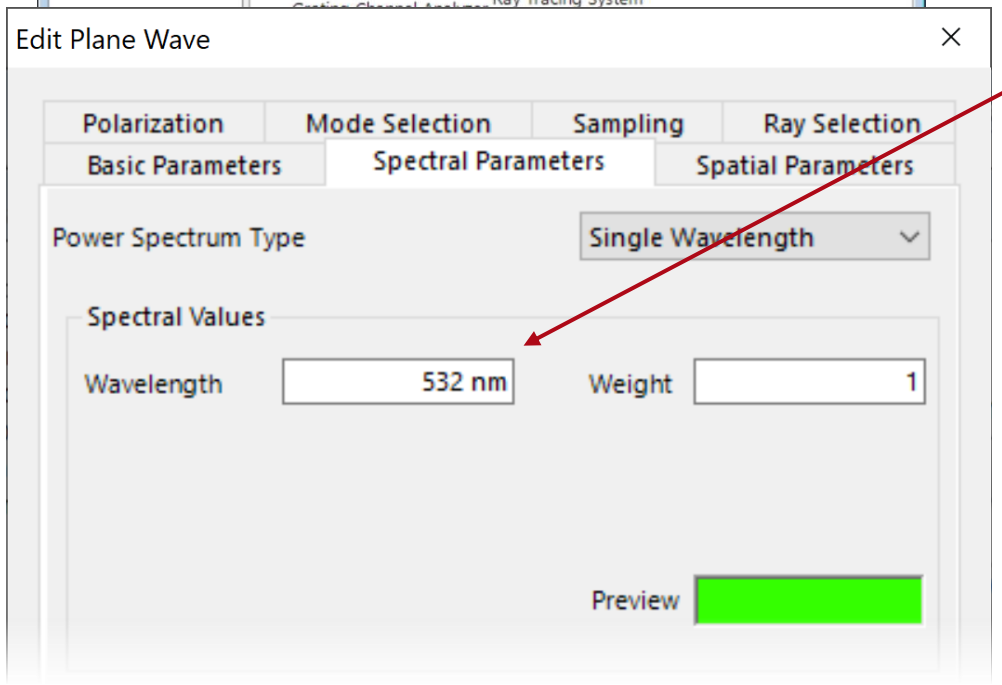
EPE region
- position and complex shape
- grating orientation
- grating period



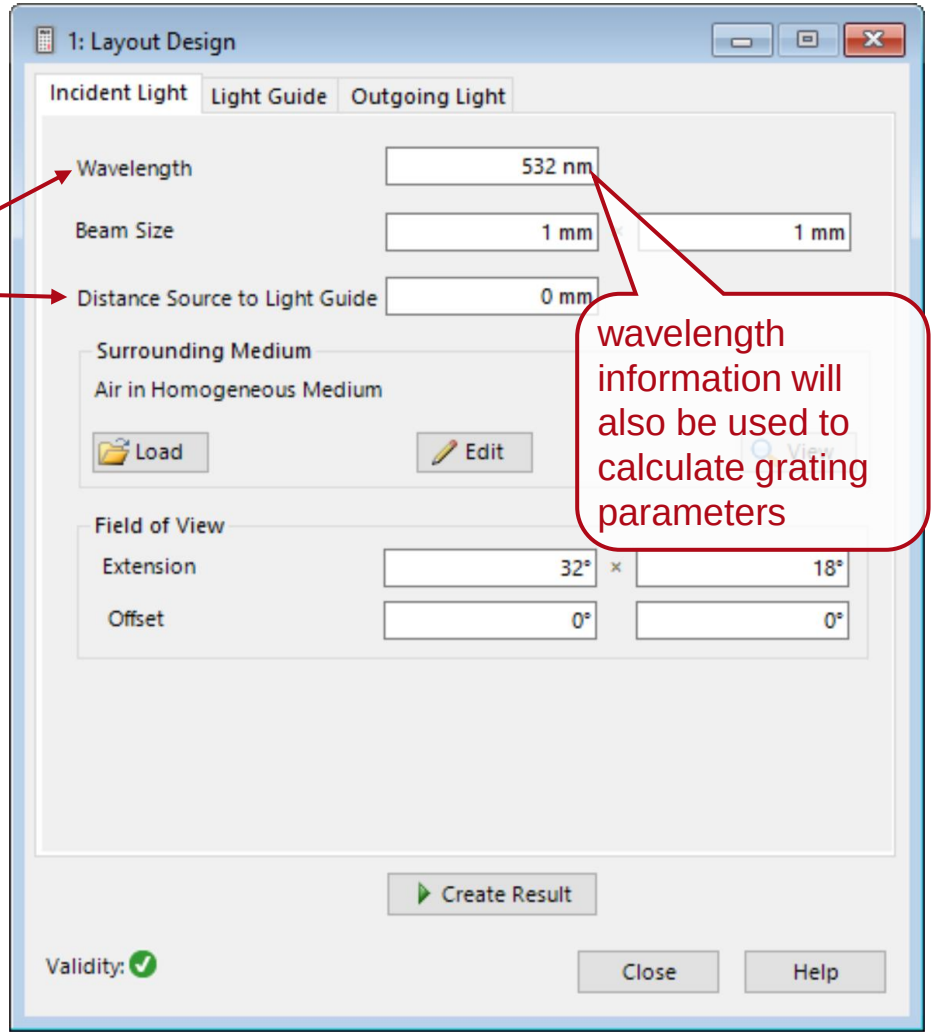
incoupling region
- grating period
- lateral extension

Automatic Generation of Optical Setup with Lightguide

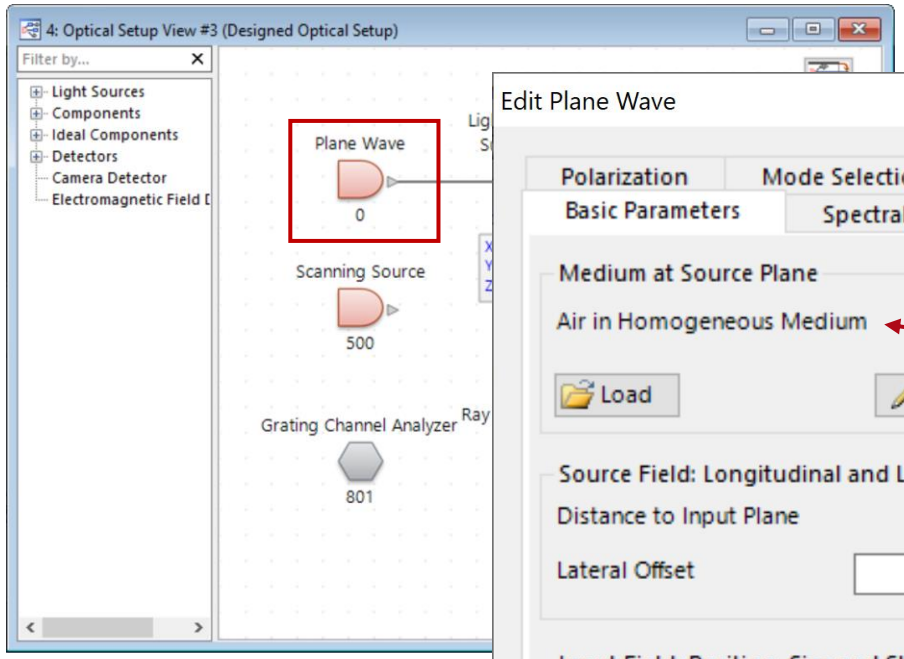


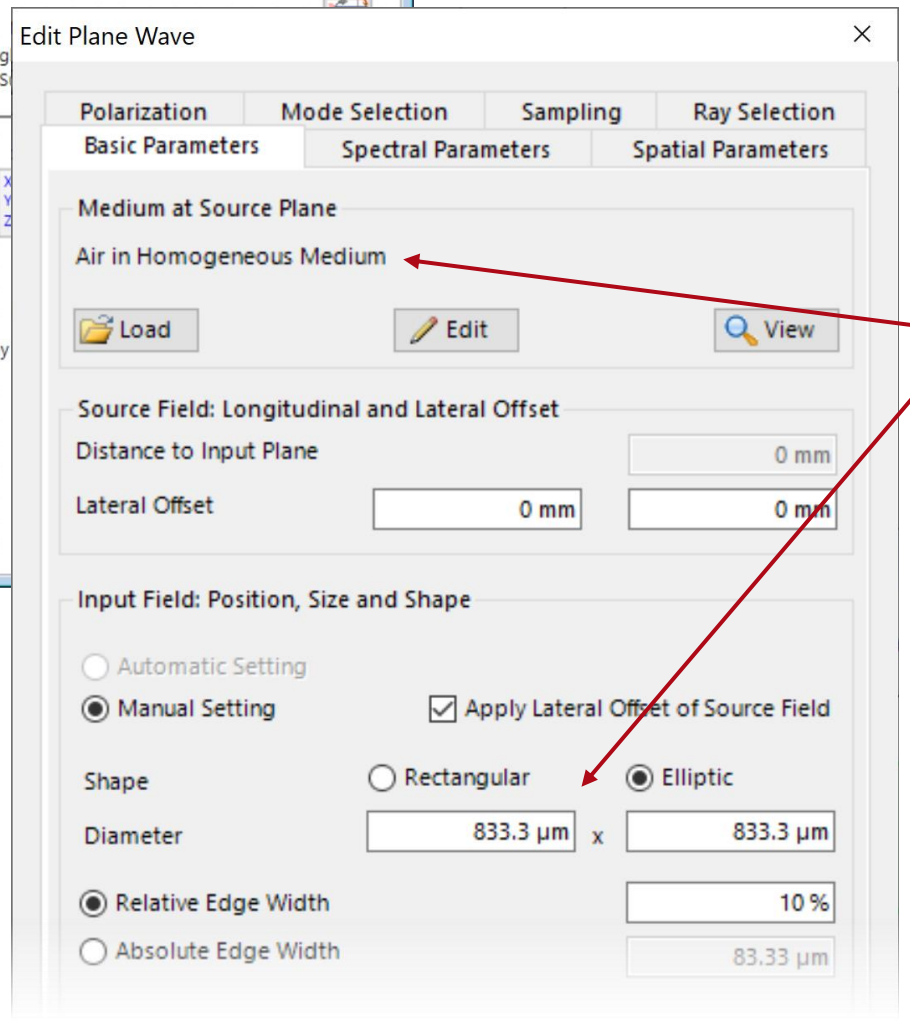


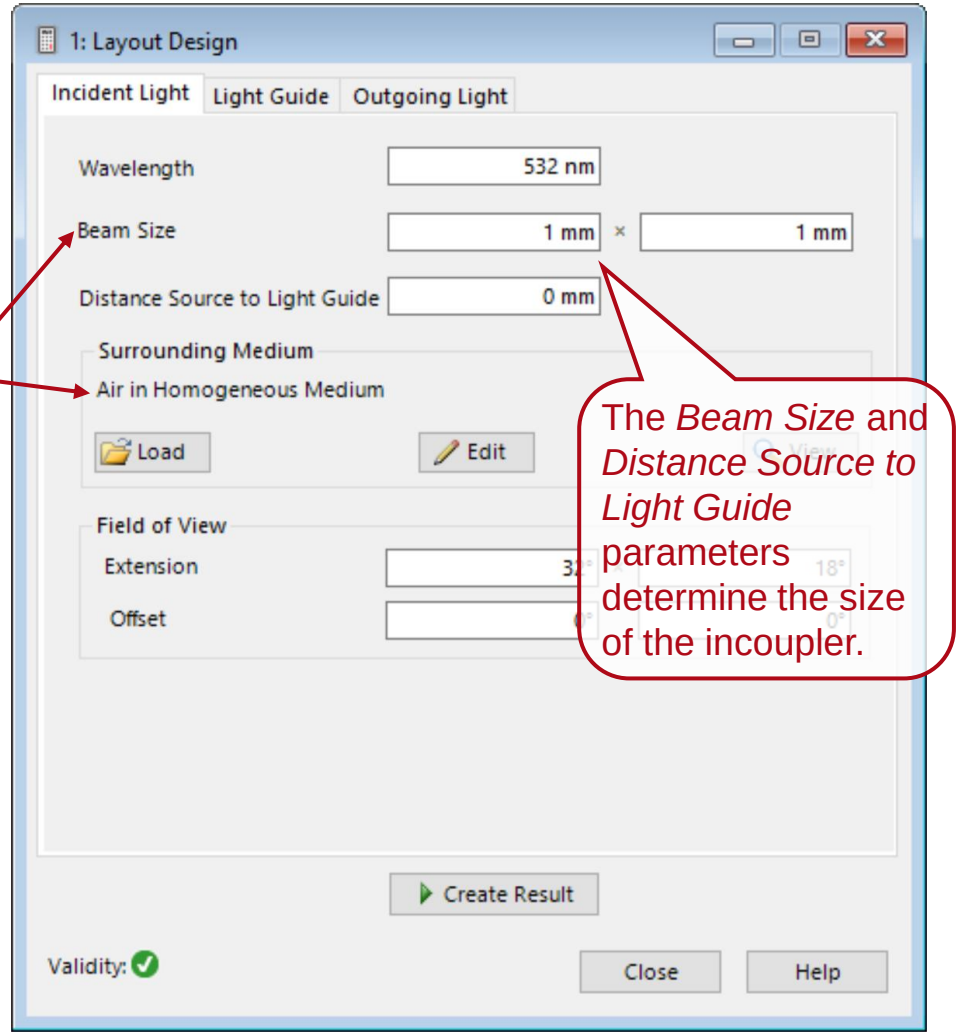
The *Layout Design* tool will automatically generate an *Optical Setup* where the position and parameters of source, component and detectors are specified according to the parameters in the tool.



Plane Wave Source Specifications



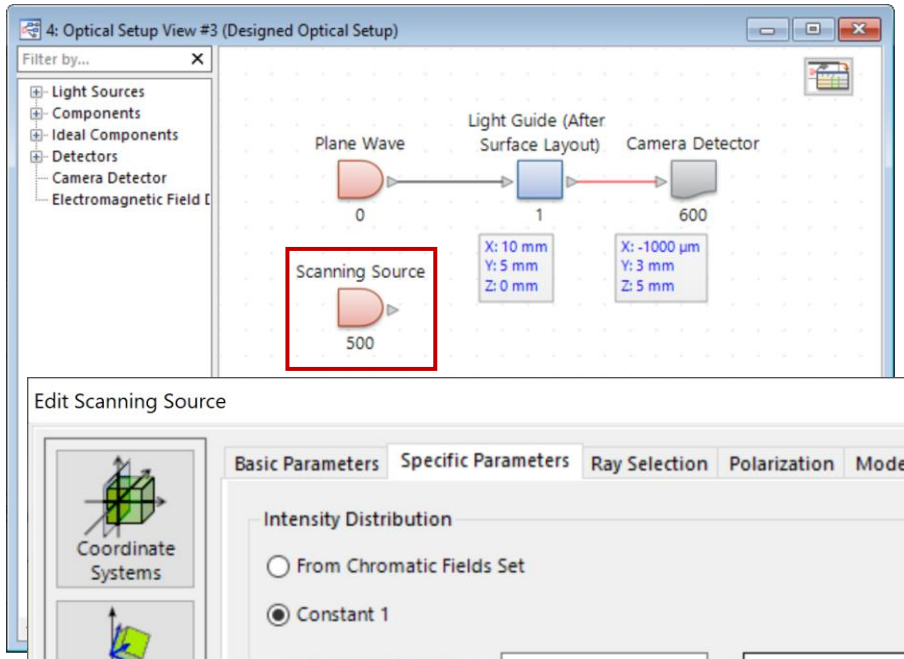


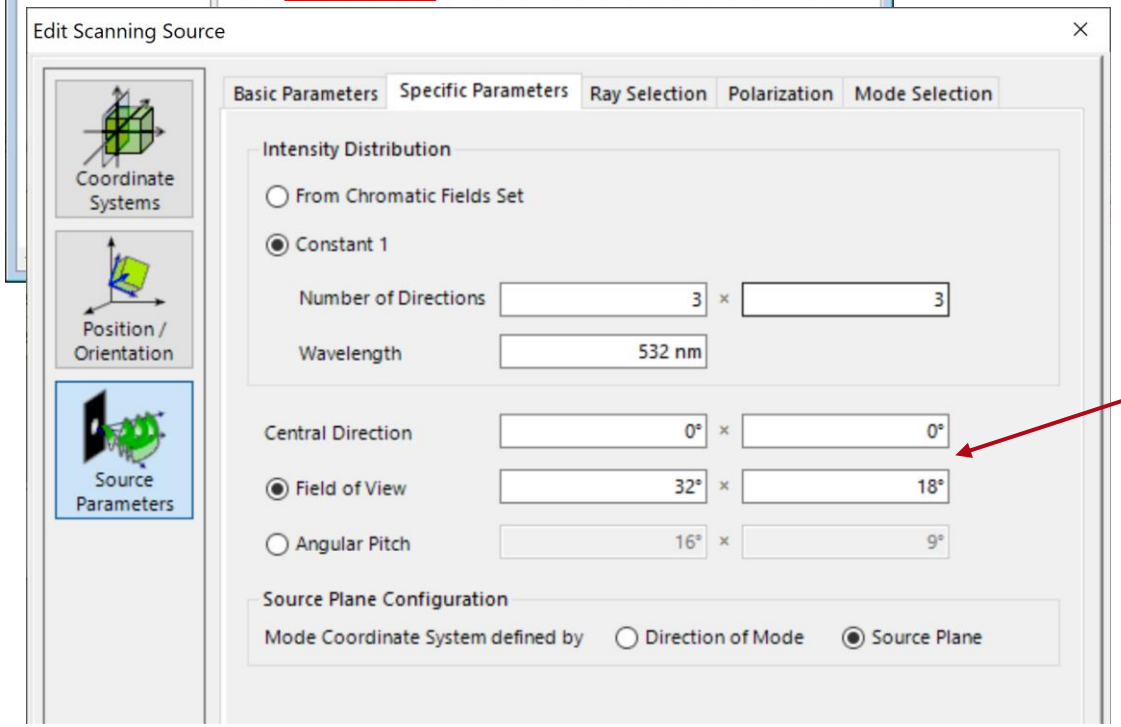


The *Beam Size* and *Distance Source to Light Guide* parameters determine the size of the incoupler.

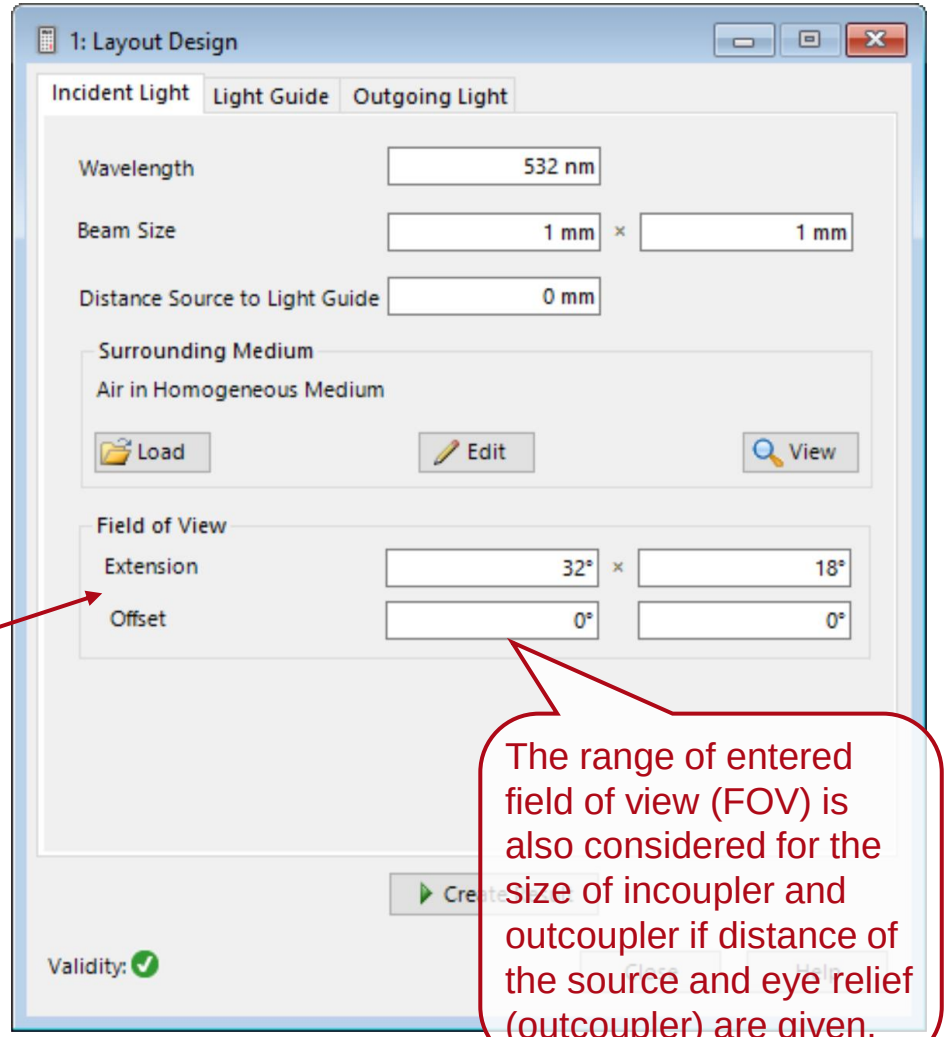
The *Diameter* of the source is automatically adjusted in order to include a necessary soft edge.

Scanning Source Specifications



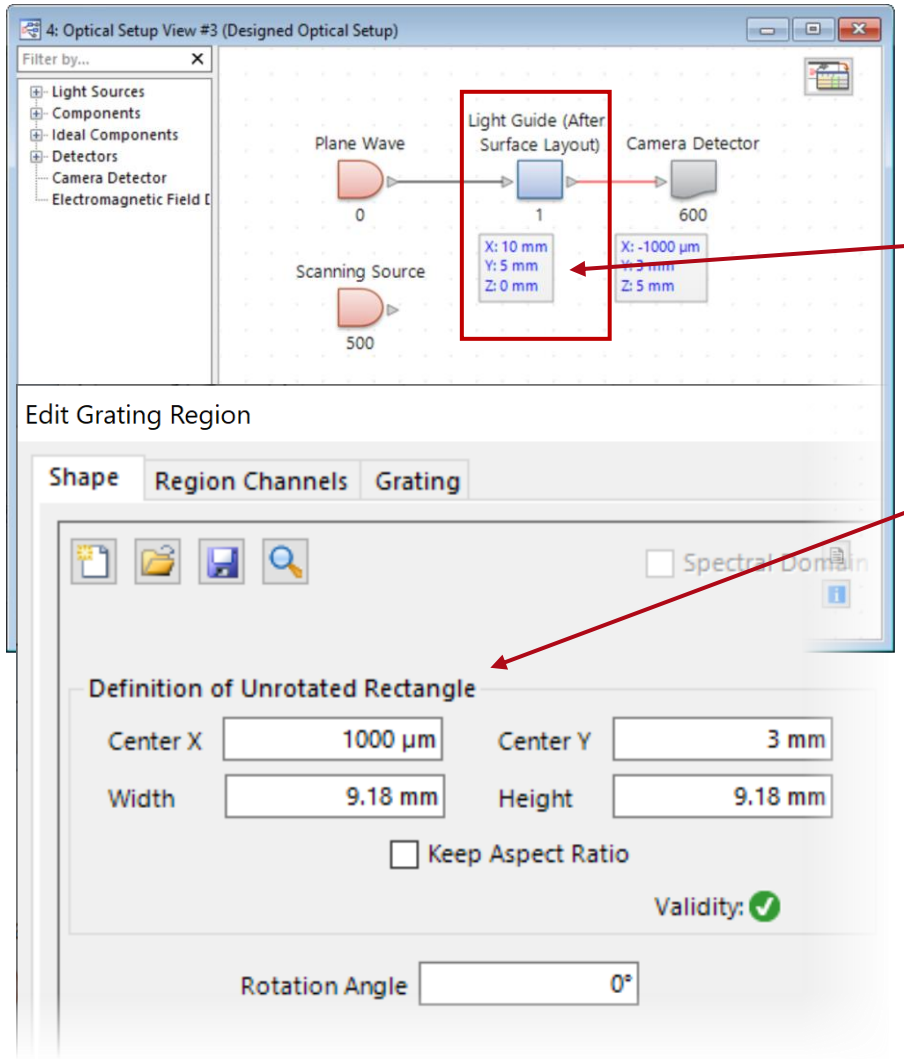


All relevant source parameters are automatically adjusted in both *Plane Wave Source* and *Scanning Source*.



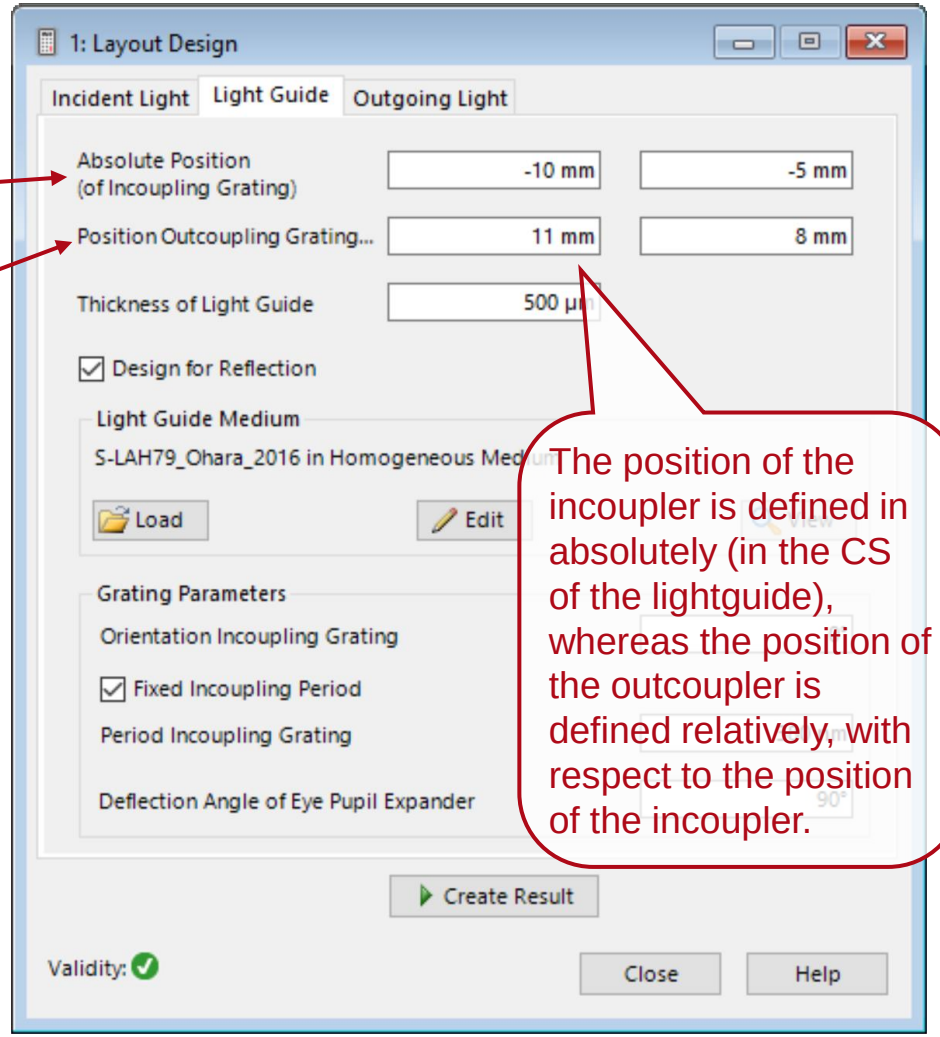
The range of entered field of view (FOV) is also considered for the size of incoupler and outcoupler if distance of the source and eye relief (outcoupler) are given.

Positioning of Component & Grating Regions



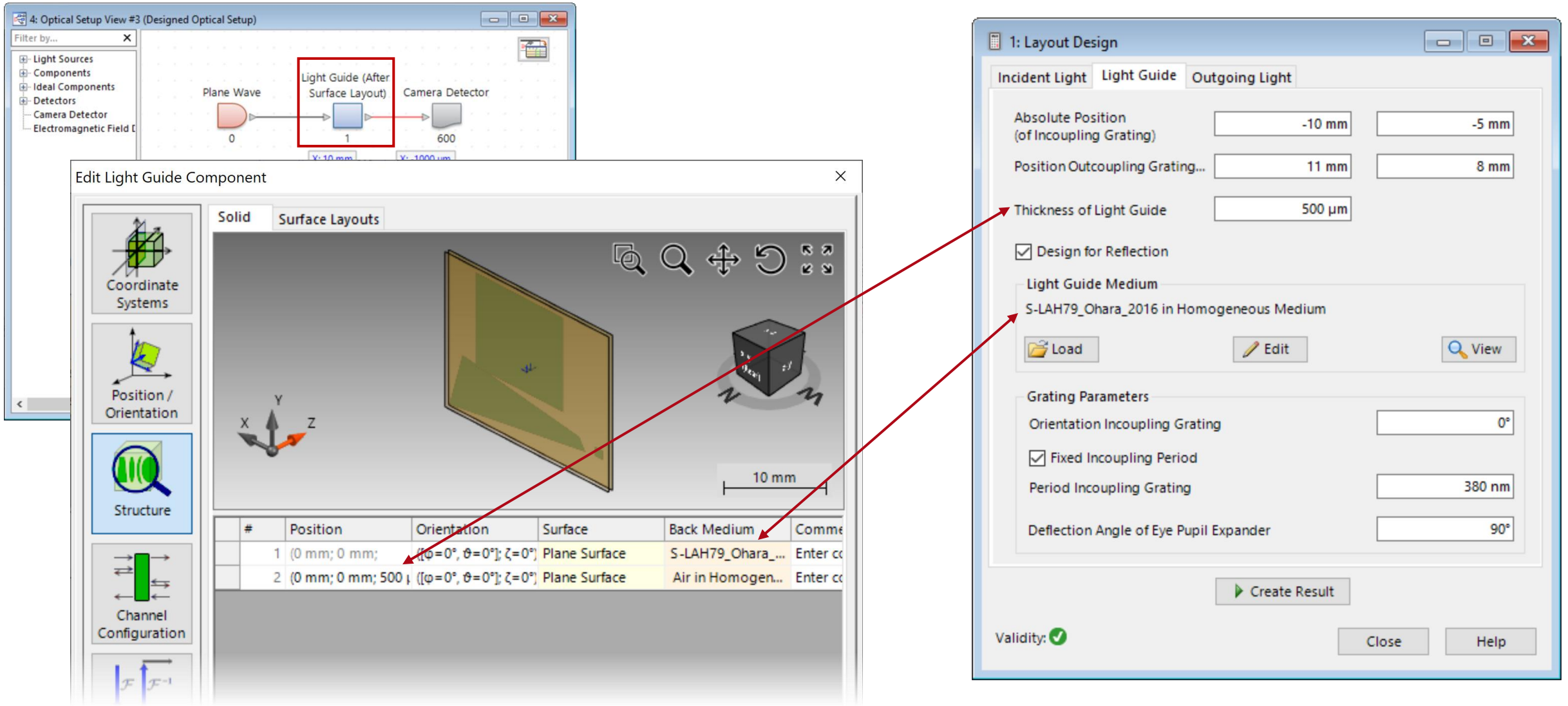
The position of the *Light Guide Component* itself and the grating regions on the surfaces are automatically adjusted according to the given specifications.

The size and shape of the expansion grating is automatically calculated.

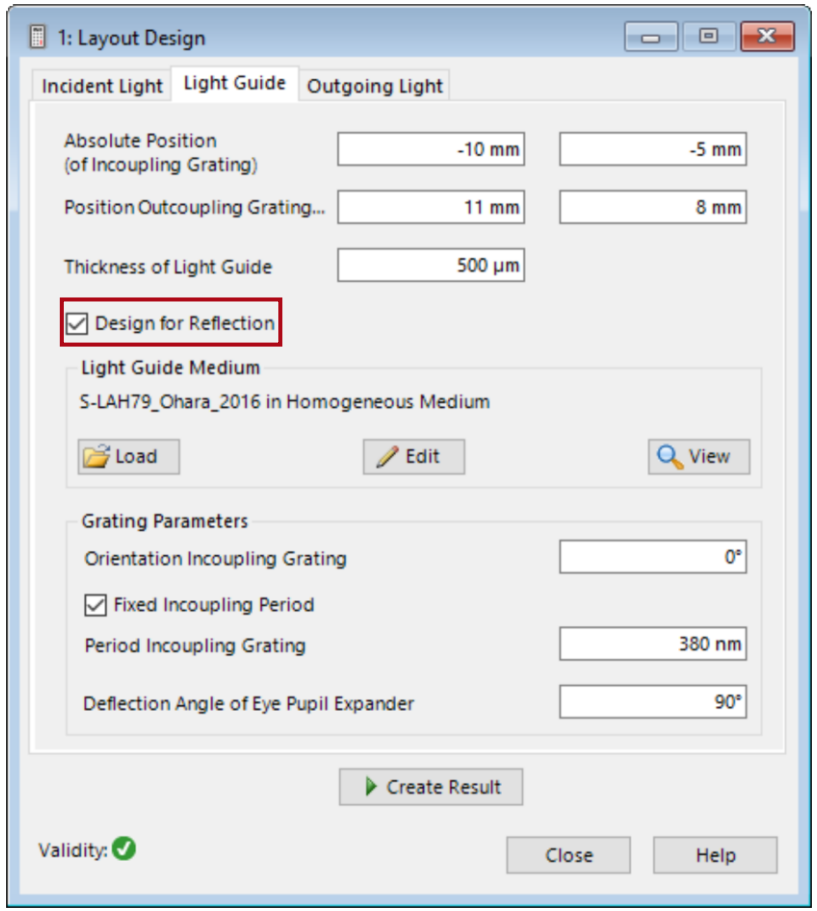


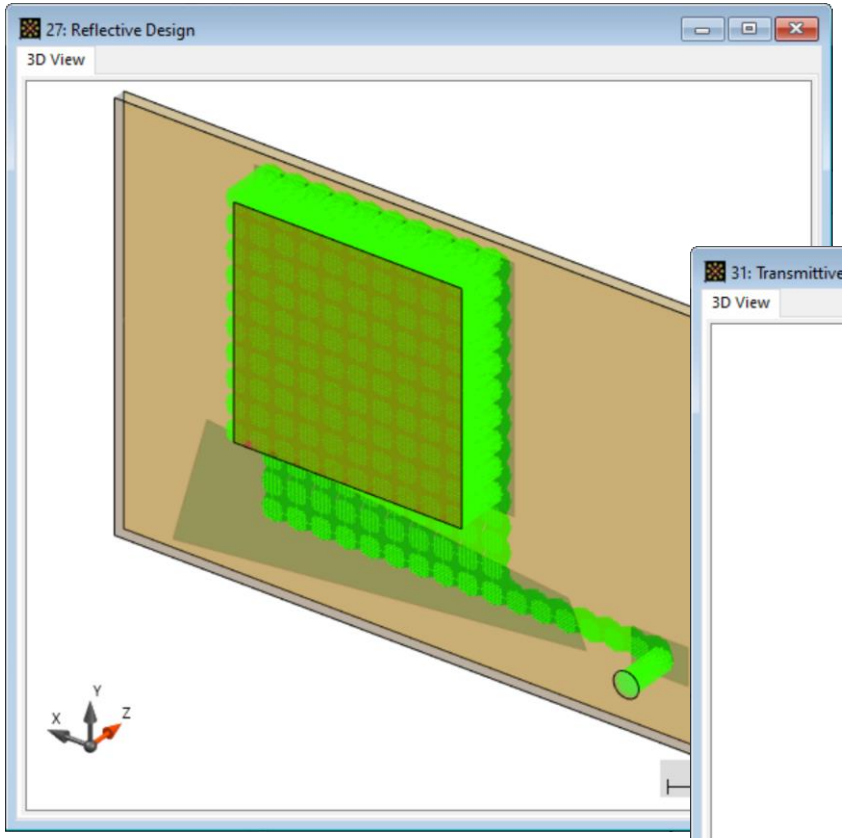
The position of the incoupler is defined in absolutely (in the CS of the lightguide), whereas the position of the outcoupler is defined relatively, with respect to the position of the incoupler.

Parameters of the Lightguide

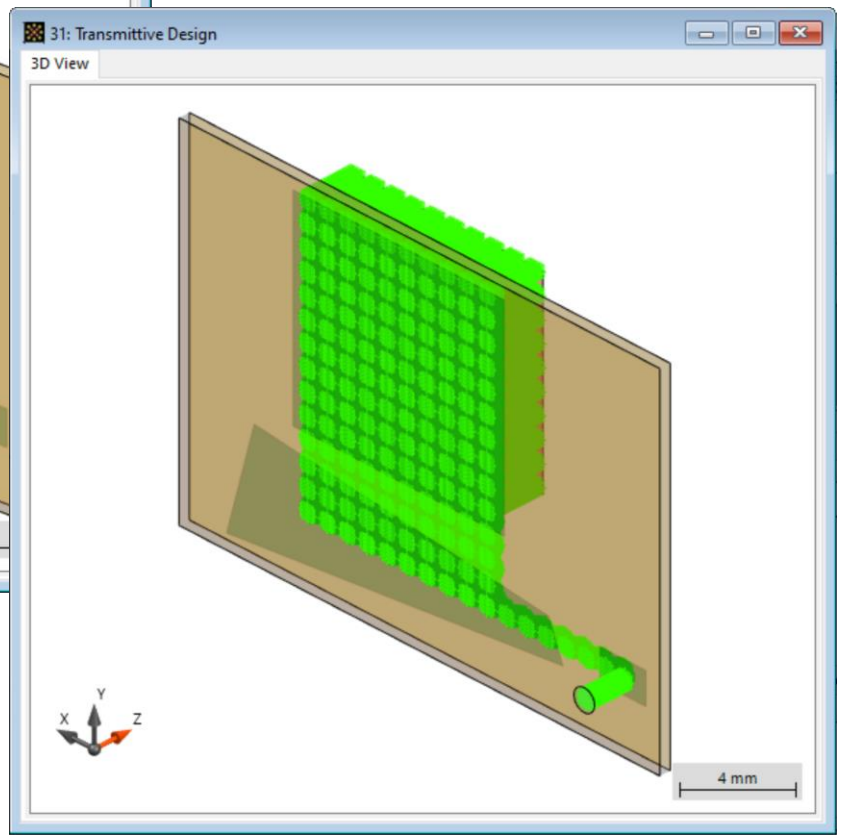


Design for Transmission or Reflection



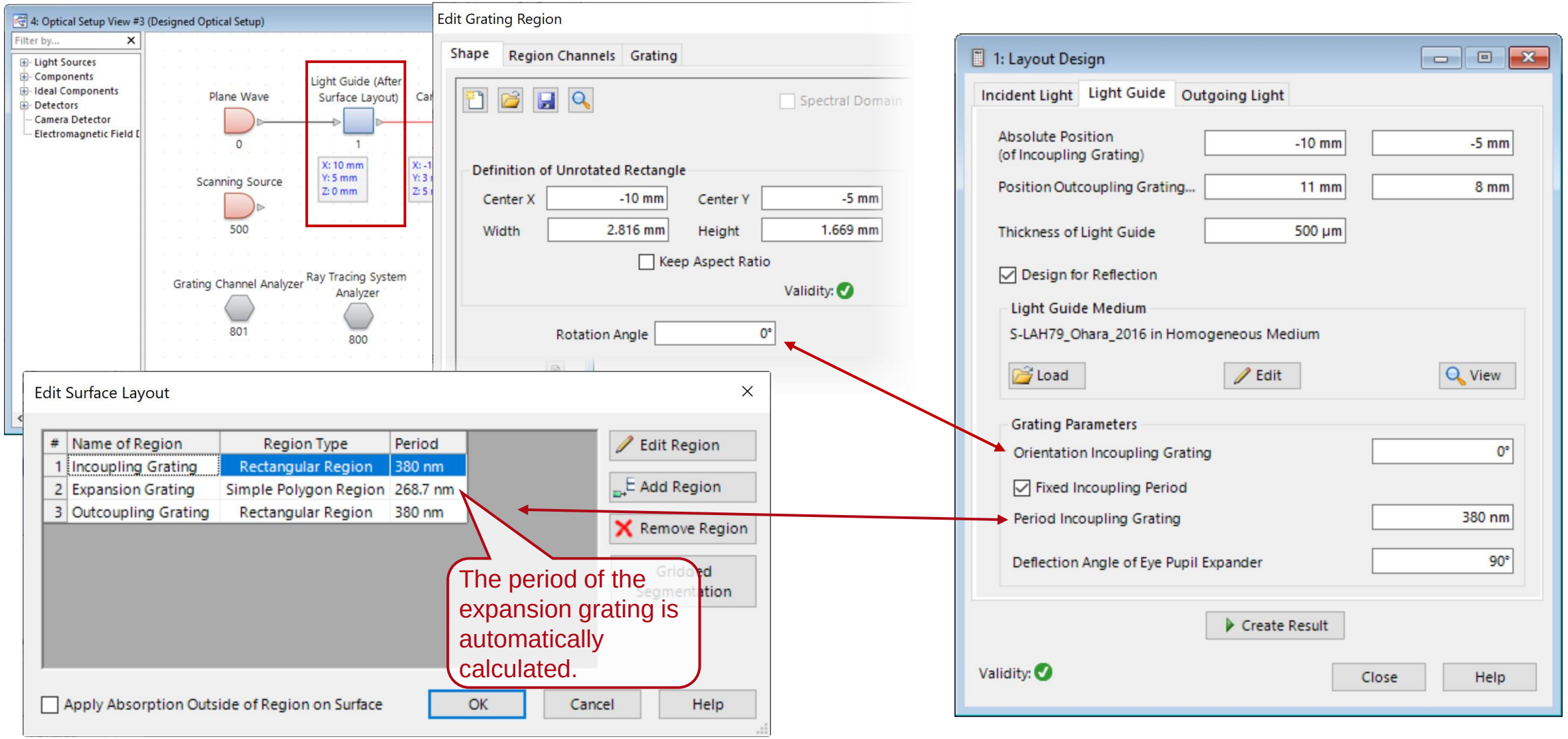


Note: Distance between source, lightguide and detector are increased for illustrational purposes.

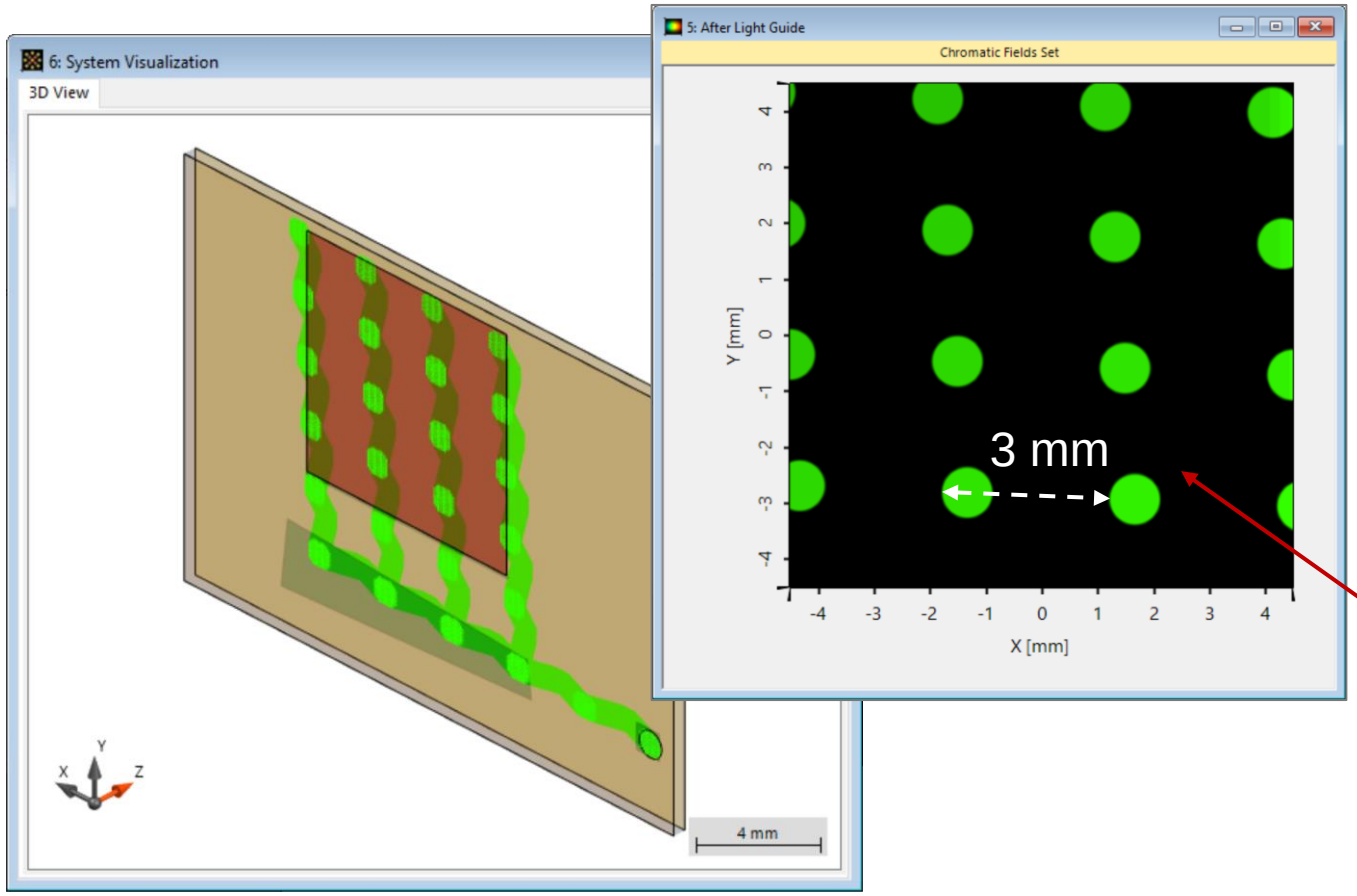


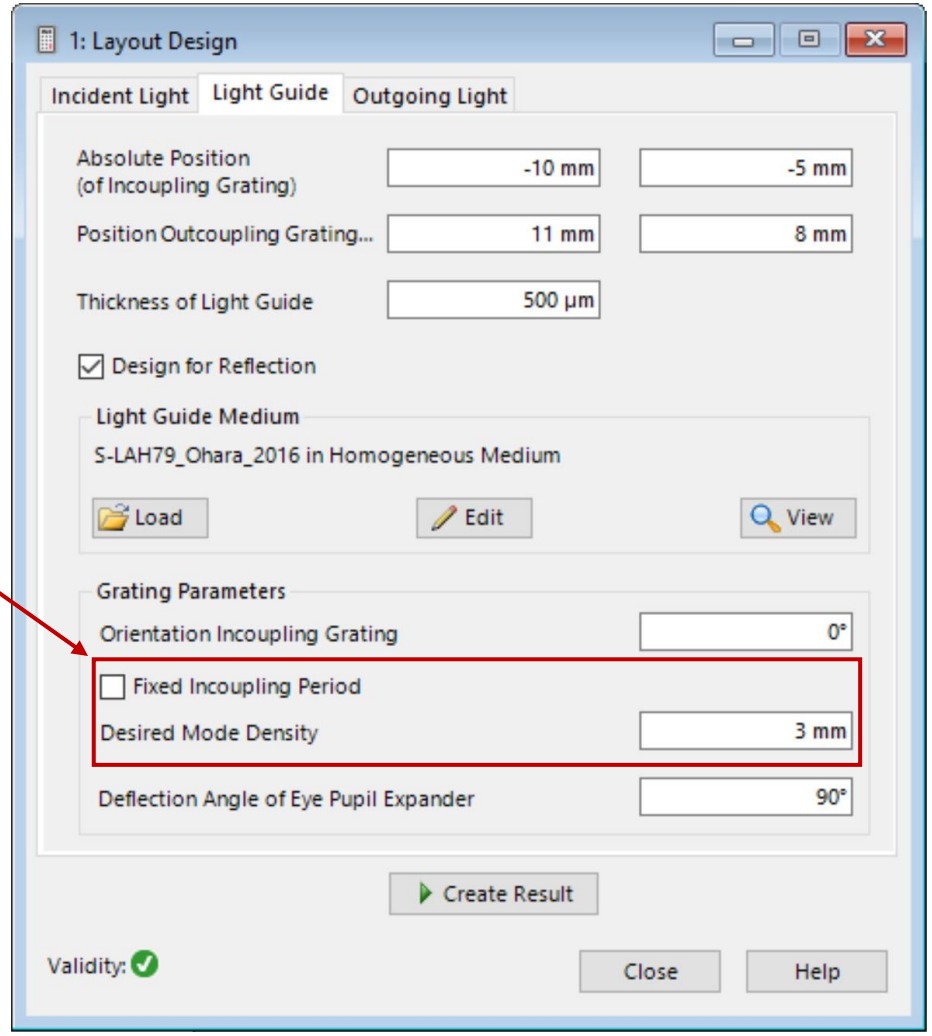
The user can choose whether the lightguide should work in transmission or reflection, means on which side the light is going to be outcoupled.

Parameters of Grating Regions



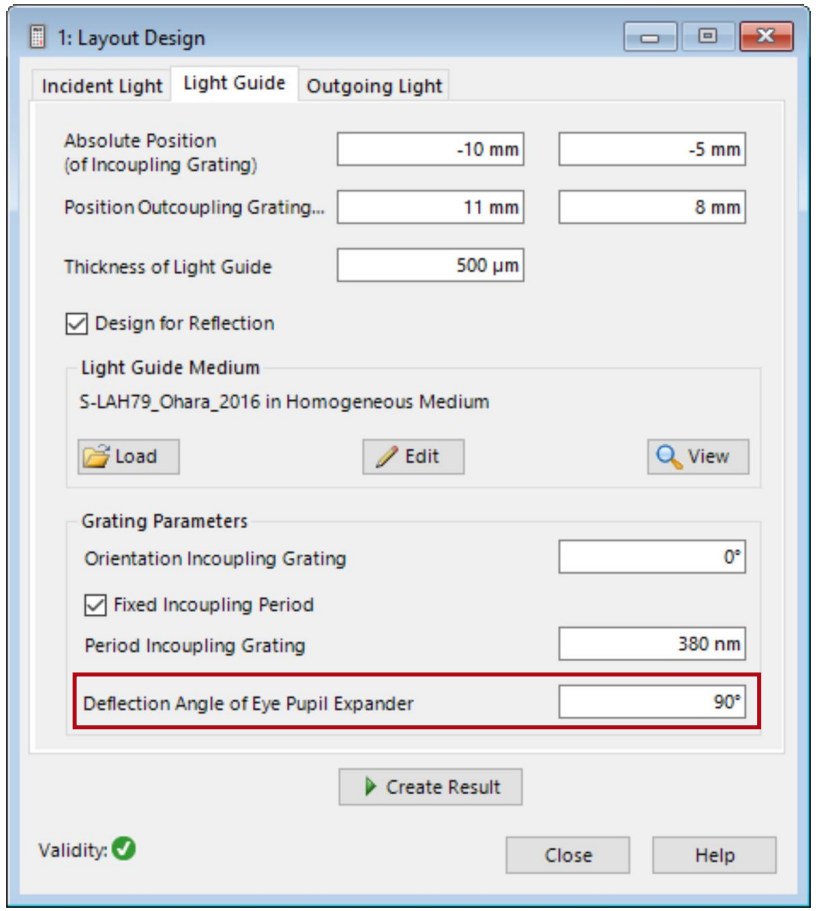
Parameters of Grating Regions

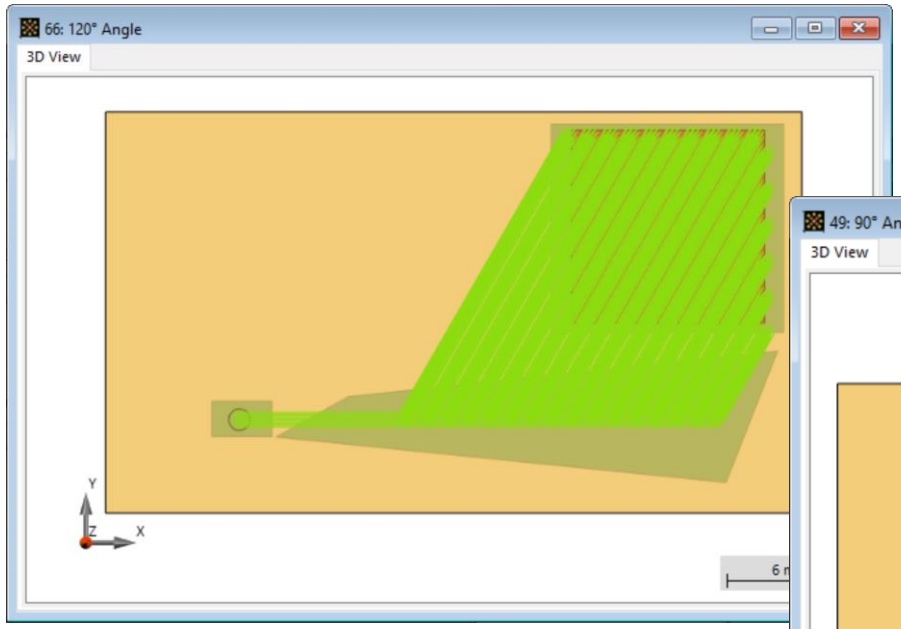




Instead of defining a period for the incoupling grating, a (minimum) *desired mode density* in the eye box can be specified. This value is used to estimate an adequate period of the incoupler.

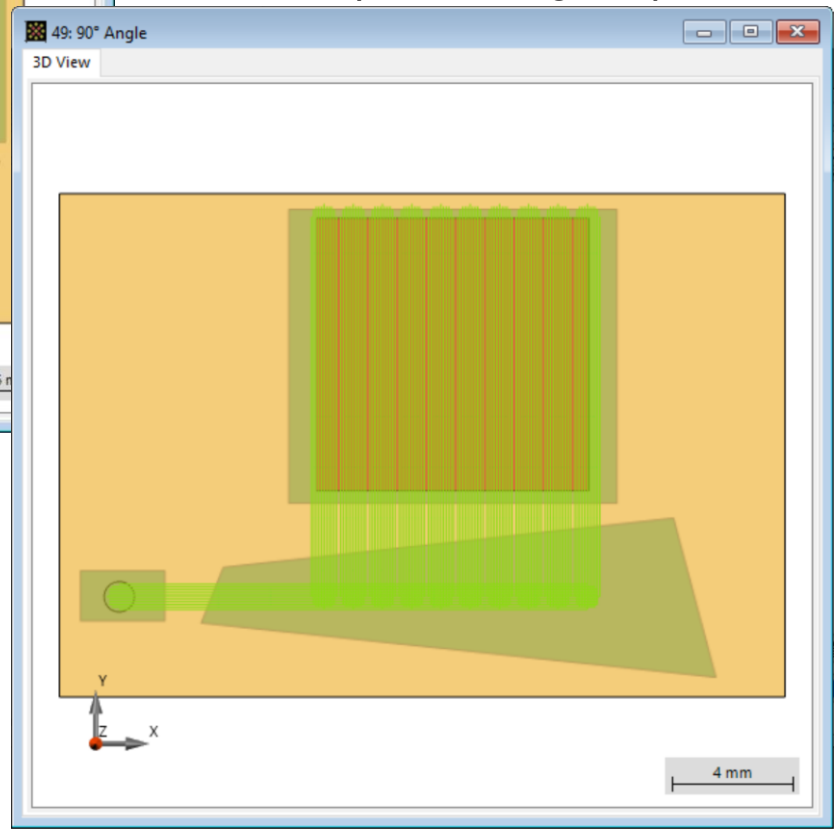
Deflection Angle Setting





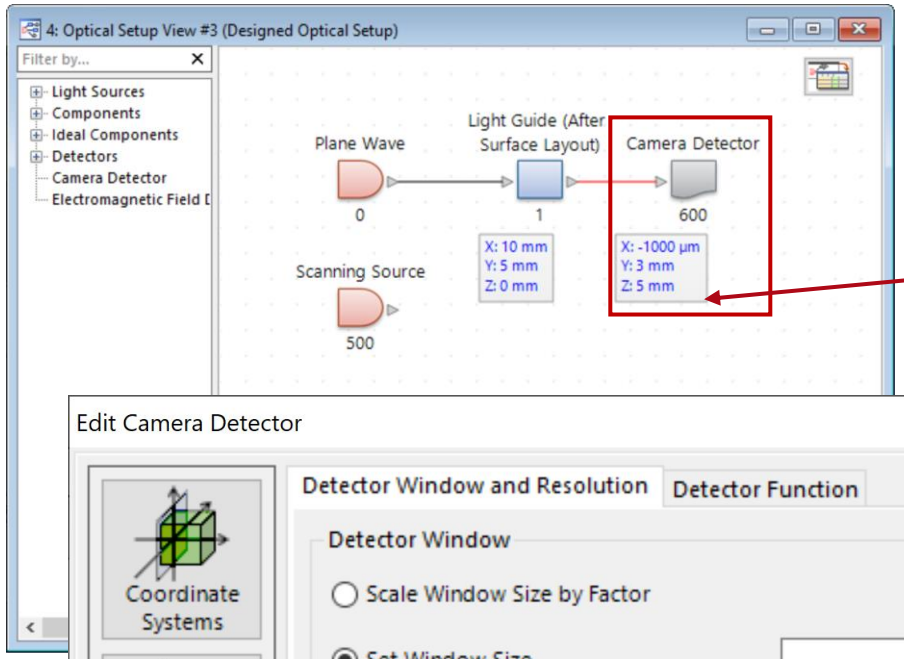
120° (*Note: Position Outcoupling Grating has been set to 19mm in x-direction and 9mm in y-direction to avoid overlap of the regions*)

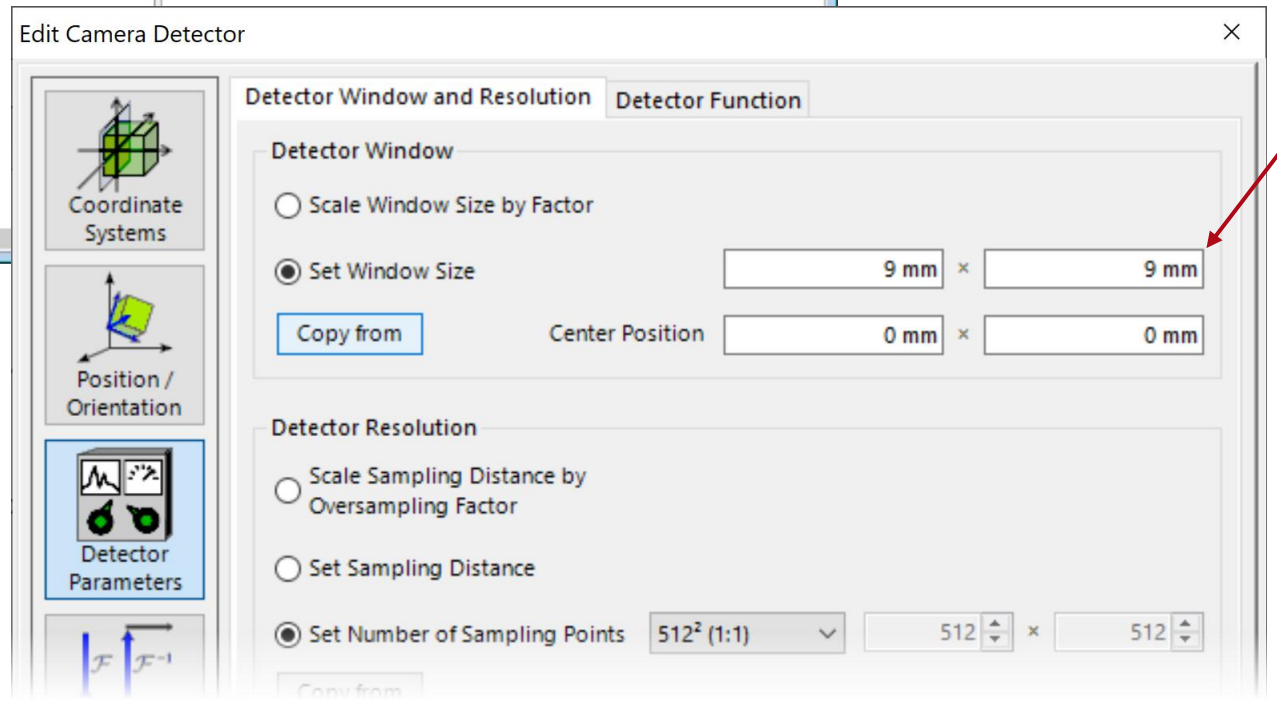
The parameter *Deflection Angle of Eye Pupil Expander* enables to modify the diffraction angle at the EPE and thus adjusts the positions and orientations of the EPE and outcoupling grating accordingly. This provides an additional degree of freedom for complex lightguide designs.

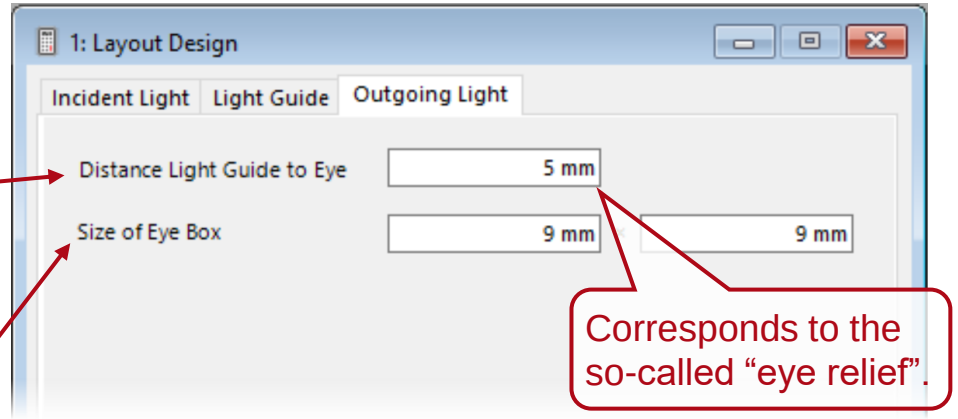


90°

Detector Settings





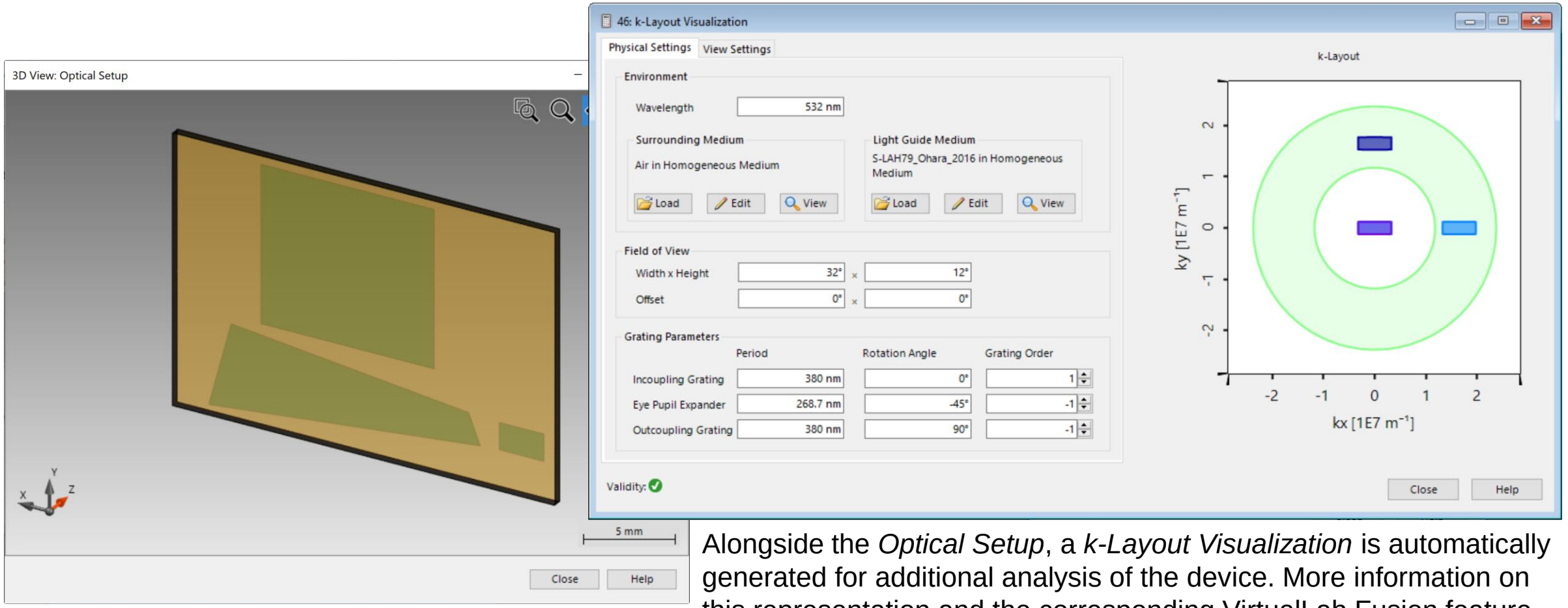


The position and window size of the detector (*Camera Detector* by default) are specified by the settings in the tool. Additional parameters like sampling can be adjusted by the user if needed. It is also possible to add additional detectors into the system after the layout design process has completed.

Overview of Parameter Dependencies and Contributions

Parameter in Light Guide	**Calculated from:**
Size of incoupler	*Beam Size*, *Distance Source to Light Guide*, *FOV*
Period of incoupler	• *Period Incoupling Grating* • *Desired Mode Density*, *Wavelength*, *Distance Source to Light Guide, Thickness of Light Guide*
Size of outcoupler	*Size eye box*, *Thickness of Light Guide, Distance Light Guide to Eye, FOV, Beam Size*
Period of outcoupler	• *Period Incoupling Grating* • *Desired Mode Density*, *Wavelength*, *Distance Source to Light Guide, Thickness of Light Guide*
Shape of Eye Pupil Expander	*Deflection Angle of Eye Pupil Expander*, position of incoupler and outcoupler, *Beam Size*
Period of Eye Pupil Expander	*Deflection Angle of Eye Pupil Expander*, *Wavelength*, period of incoupler, *FOV, Beam Size*

Results



Alongside the *Optical Setup*, a *k-Layout Visualization* is automatically generated for additional analysis of the device. More information on this representation and the corresponding VirtualLab Fusion feature can be found under:
k-Domain Layout Visualization

Document Information

title	Light Guide Layout Design Tool
document code	LIG.0005
document version	1.0
software edition	VirtualLab Fusion Advanced, Light Guide Toolbox Gold Edition
software version	2021.1 (Build 1.180)
category	Feature Use Case
further reading	- k-Domain Layout Visualization - Construction of a Light Guide - Modeling of a “HoloLens 1”-Type Layout with Light Guide Component - Flexible Region Definition - Specification of Diffraction Orders and Efficiencies for Grating Regions - Light Guide Design Tool