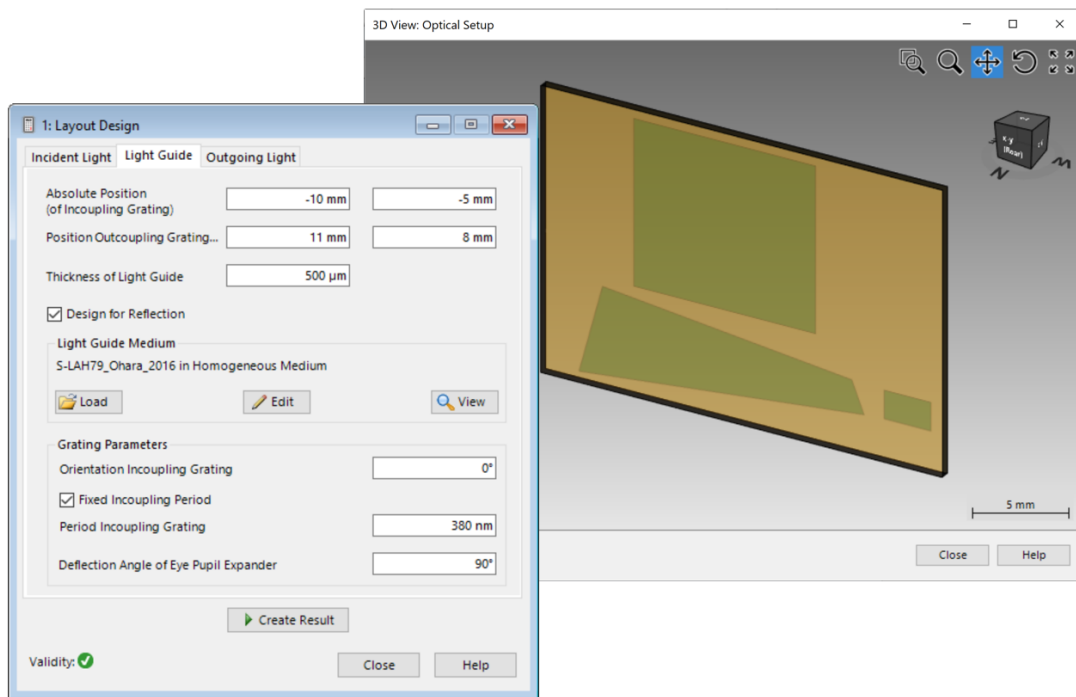


Light Guide Layout Design Tool

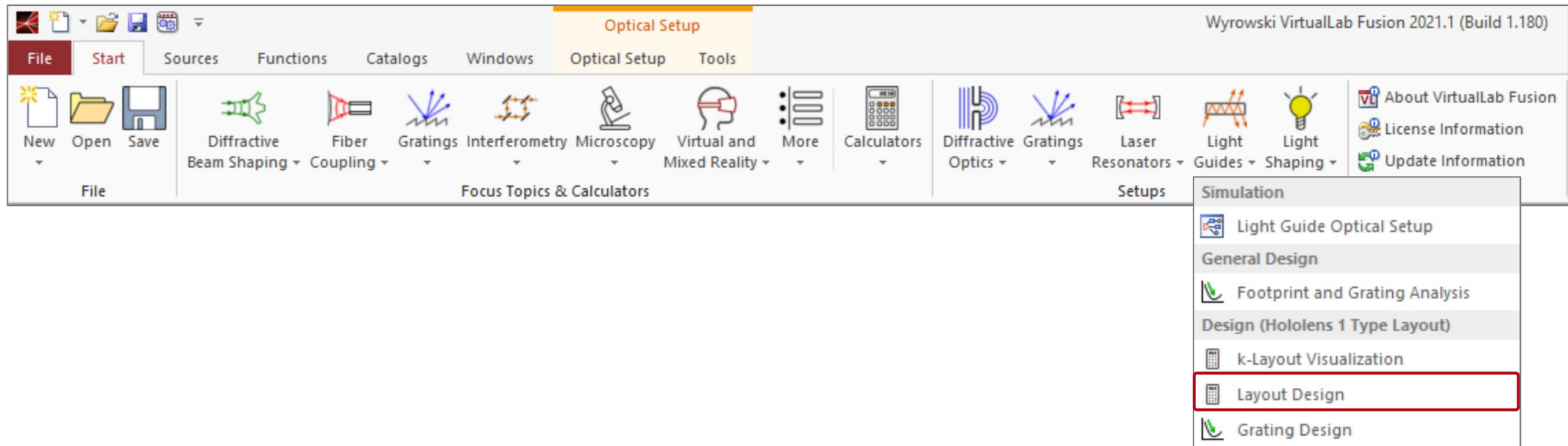
Abstract



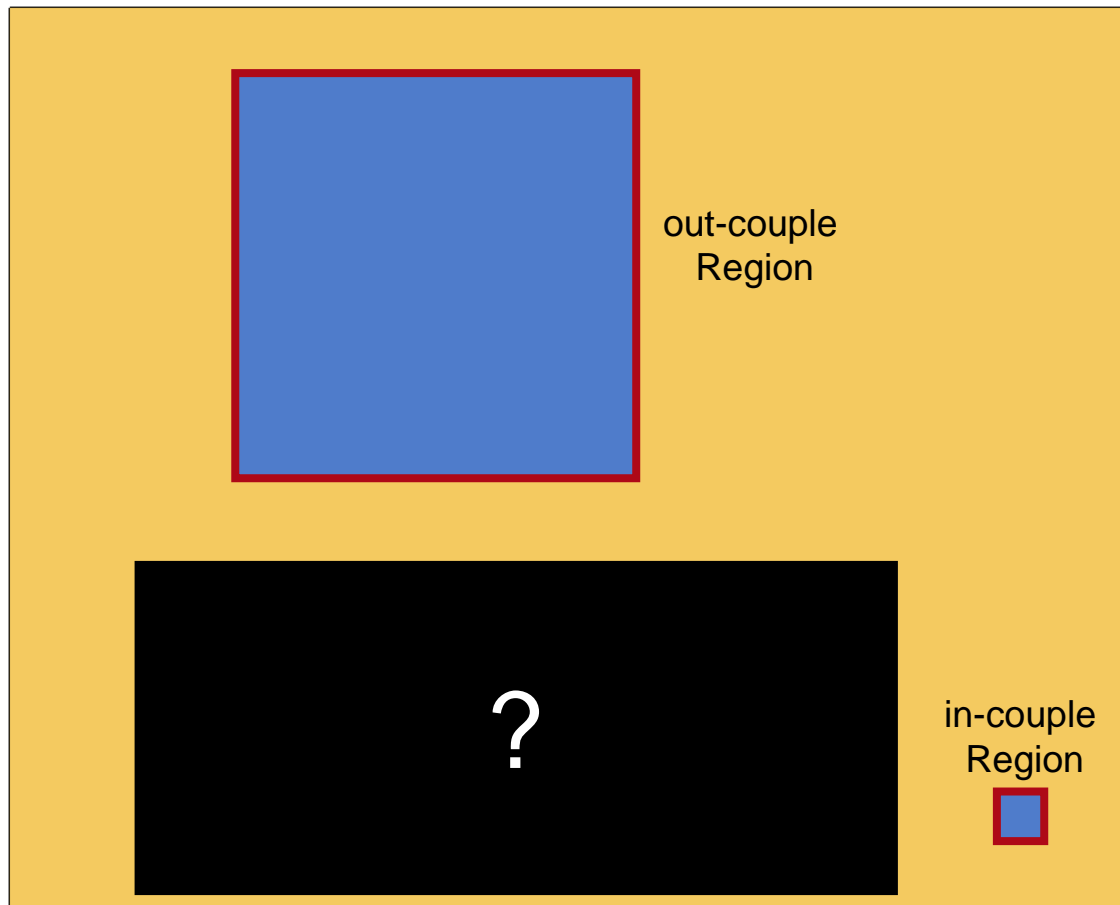
With the advances in augmented and mixed reality (AR & MR) technology, lightguide devices have become the object of increasing interest. To help the optical engineer with the design of such systems, VirtualLab Fusion offers several systematic design tools that break down the task into a controlled, step-by-step 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

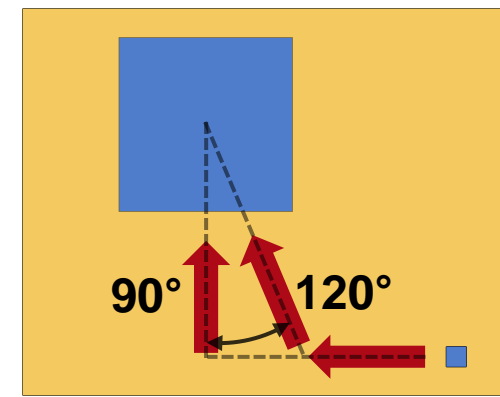
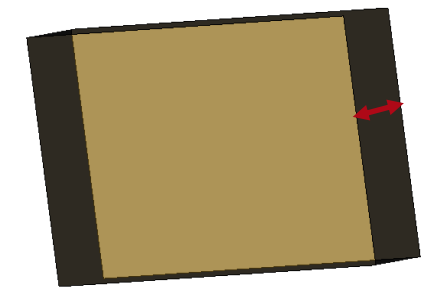
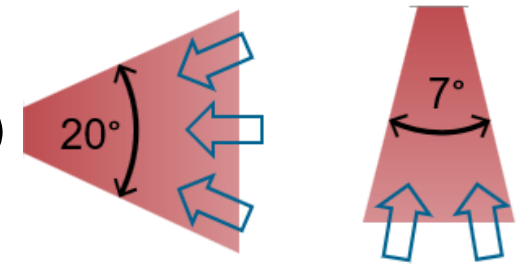
- The *Layout Design* tool is a special calculator in the *Light Guide Toolbox Gold Edition*.
- It is initialized in the *Light Guides* section within the *Start* ribbon of the main window.



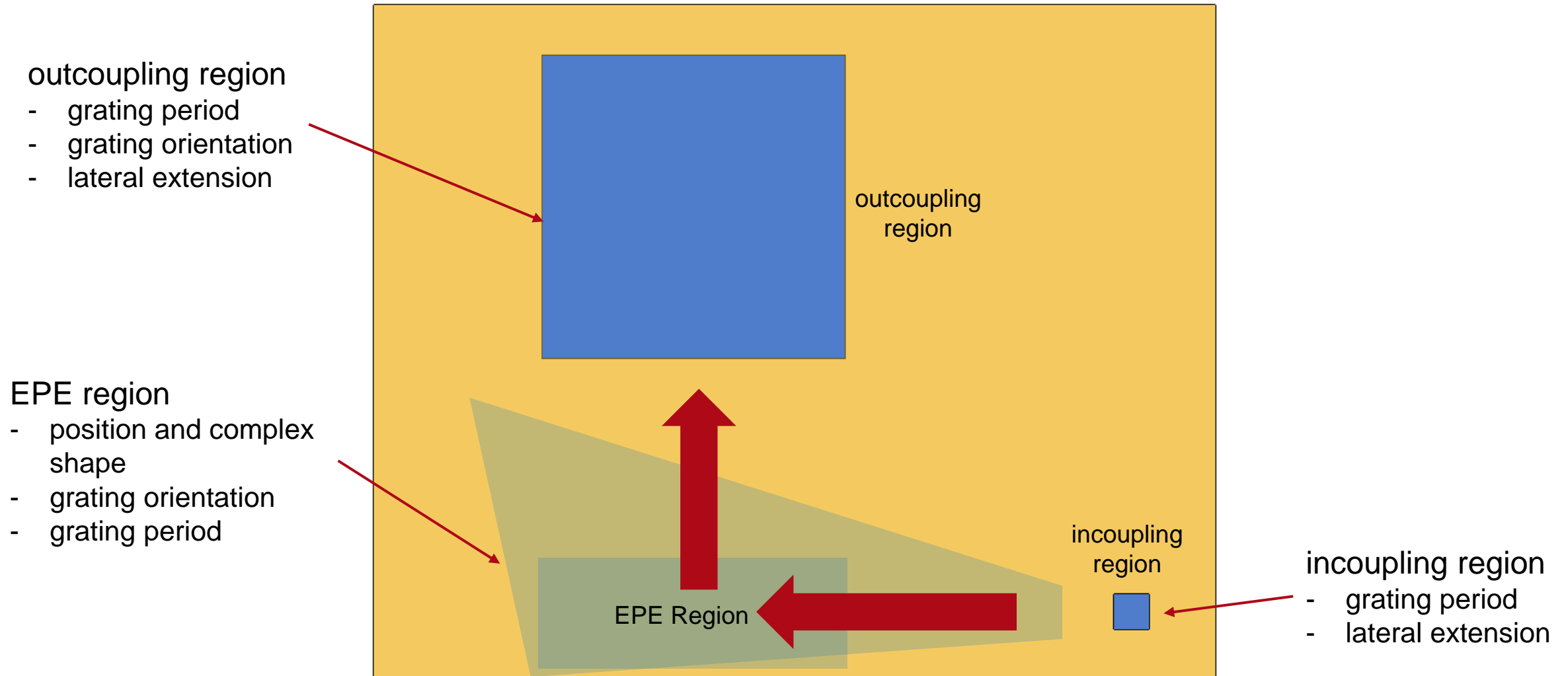
Layout Design – Setup Parameters



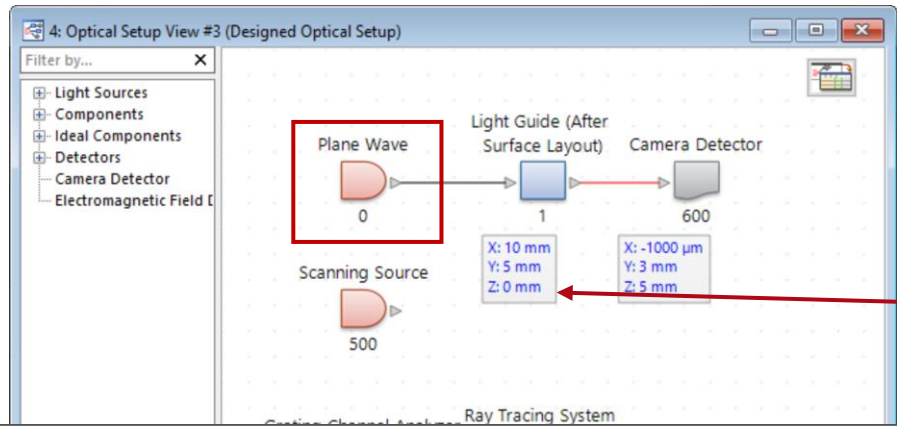
- Field of view range (FOV)
- Position & orientation of in- and outcoupling region
- Thickness of waveguide
- Eye Pupil Expansion (EPE) deflection angle



Layout Design – Calculated Parameters



Automatic Generation of Optical Setup with Lightguide



Edit Plane Wave

Polarization Mode Selection Sampling Ray Selection

Basic Parameters Spectral Parameters Spatial Parameters

Power Spectrum Type: Single Wavelength

Spectral Values

Wavelength	532 nm	Weight	1
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Preview

1: Layout Design

Incident Light Light Guide Outgoing Light

Wavelength: 532 nm

Beam Size: 1 mm x 1 mm

Distance Source to Light Guide: 0 mm

Surrounding Medium: Air in Homogeneous Medium

Field of View: Extension 32° x 18°, Offset 0° x 0°

Create Result

Validity:

Close Help

wavelength information will also be used to calculate grating parameters

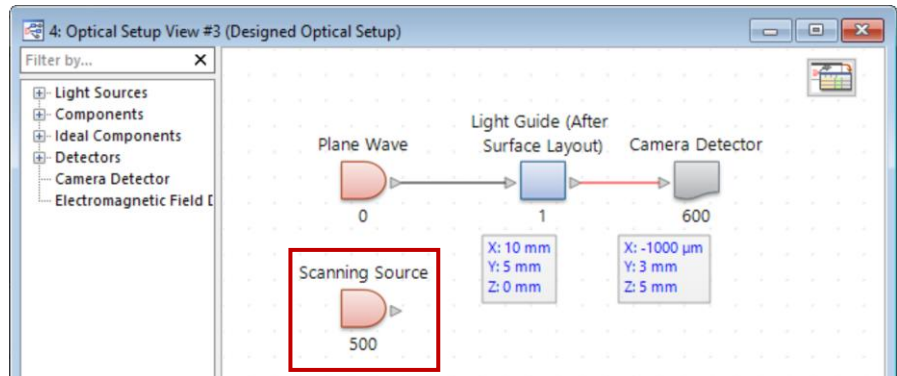
The *Layout Design* tool will automatically generate an *Optical Setup* where the position and parameters of source, component and detectors are specified according to the parameters in the tool.

Plane Wave Source Specifications

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

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

Scanning Source Specifications



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

Edit Scanning Source dialog box showing parameters for Intensity Distribution, Central Direction, and Field of View.

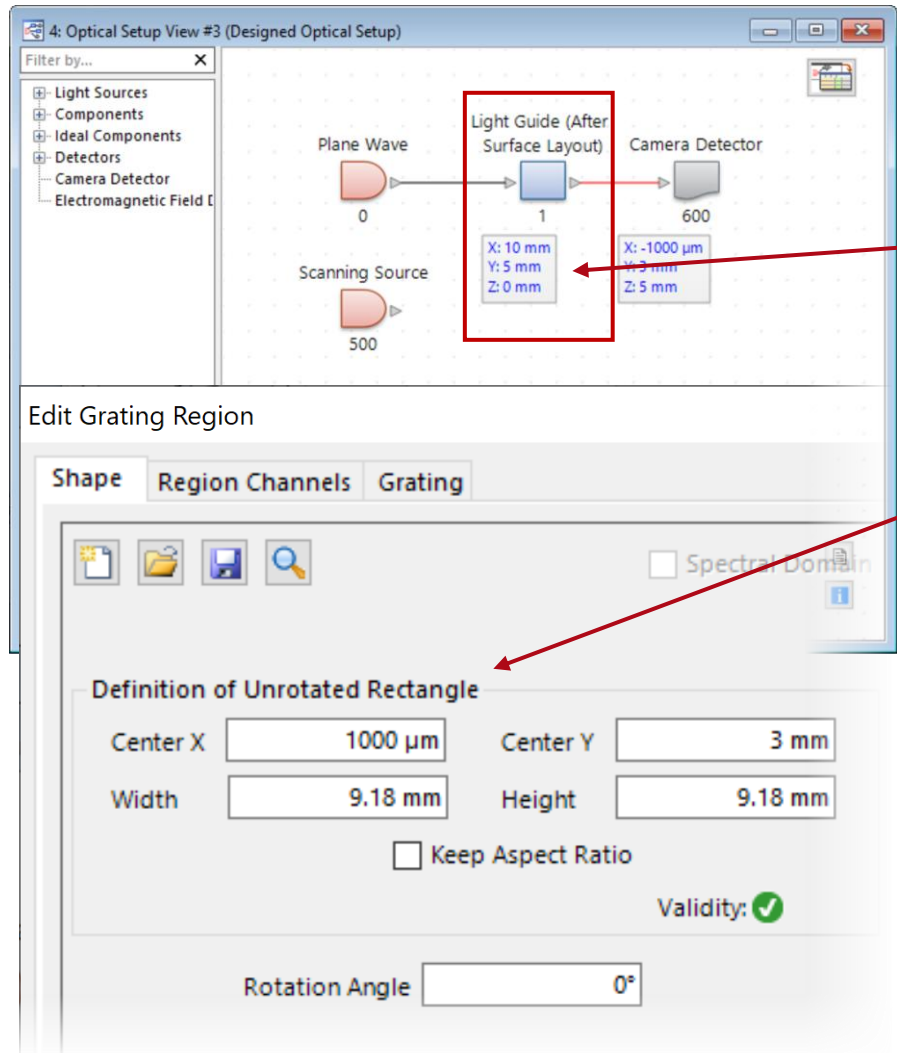
Parameter	Value
Intensity Distribution	Constant 1
Number of Directions	3 × 3
Wavelength	532 nm
Central Direction	0° × 0°
Field of View	32° × 18°
Angular Pitch	16° × 9°
Source Plane Configuration	Mode Coordinate System defined by Source Plane

1: Layout Design dialog box showing parameters for Incident Light, Light Guide, and Outgoing Light.

Parameter	Value
Wavelength	532 nm
Beam Size	1 mm × 1 mm
Distance Source to Light Guide	0 mm
Surrounding Medium	Air in Homogeneous Medium
Field of View Extension	32° × 18°
Field of View Offset	0° × 0°

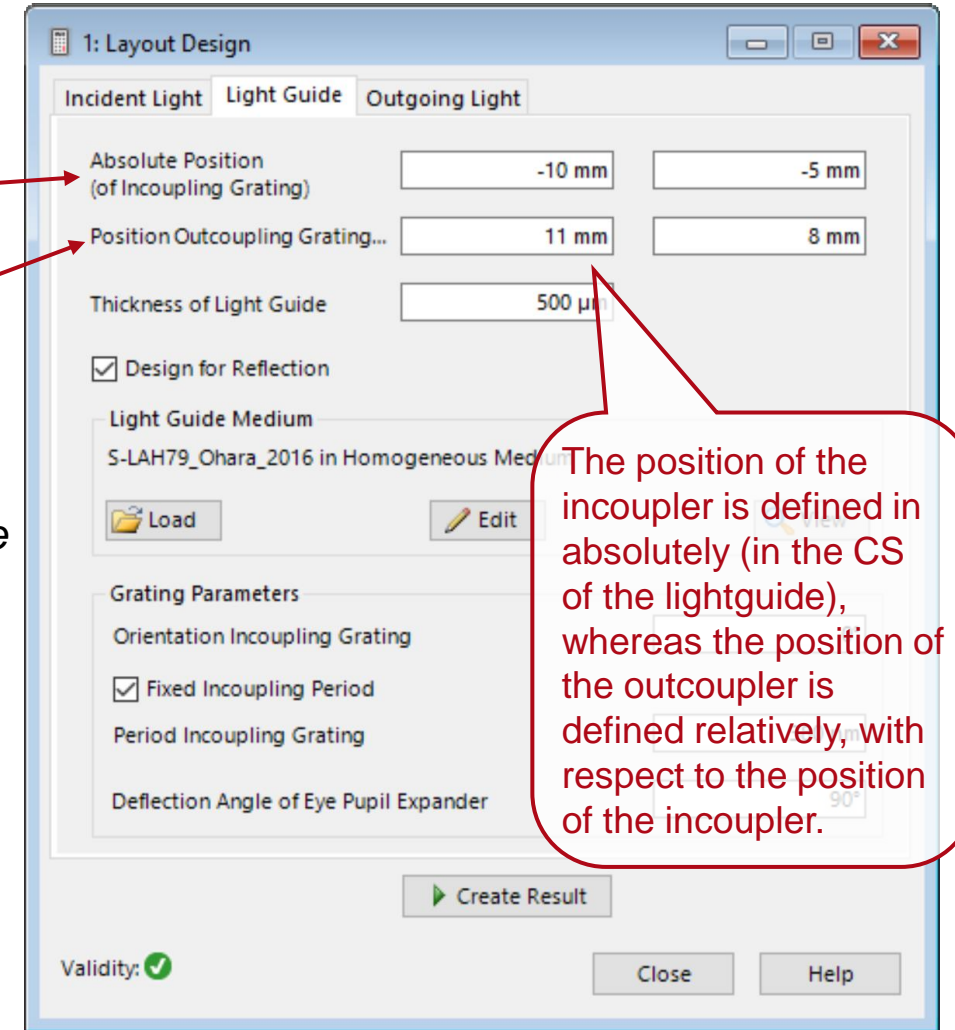
The range of entered field of view (FOV) is also considered for the size of incoupler and outcoupler if distance of the source and eye relief (outcoupler) are given.

Positioning of Component & Grating Regions



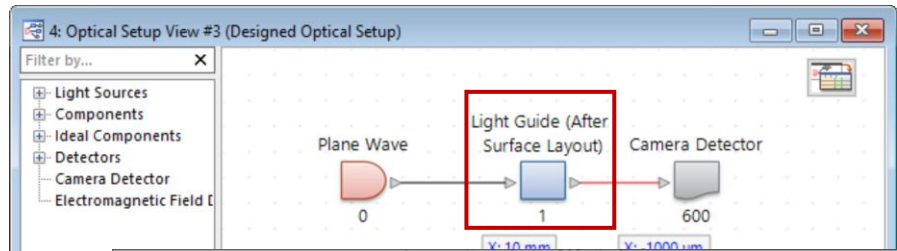
The position of the *Light Guide Component* itself and the grating regions on the surfaces are automatically adjusted according to the given specifications.

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



Edit Light Guide Component

Solid | **Surface Layouts**

#	Position	Orientation	Surface	Back Medium	Comments
1	(0 mm; 0 mm; 0 mm)	$[\phi=0^\circ, \theta=0^\circ; \zeta=0^\circ]$	Plane Surface	S-LAH79_Ohara_...	Enter co...
2	(0 mm; 0 mm; 500 μm)	$[\phi=0^\circ, \theta=0^\circ; \zeta=0^\circ]$	Plane Surface	Air in Homogen...	Enter co...

1: Layout Design

Incident Light | **Light Guide** | **Outgoing Light**

Absolute Position (of Incoupling Grating)

Position Outcoupling Grating...

Thickness of Light Guide

Design for Reflection

Light Guide Medium
S-LAH79_Ohara_2016 in Homogeneous Medium

Grating Parameters

Orientation Incoupling Grating

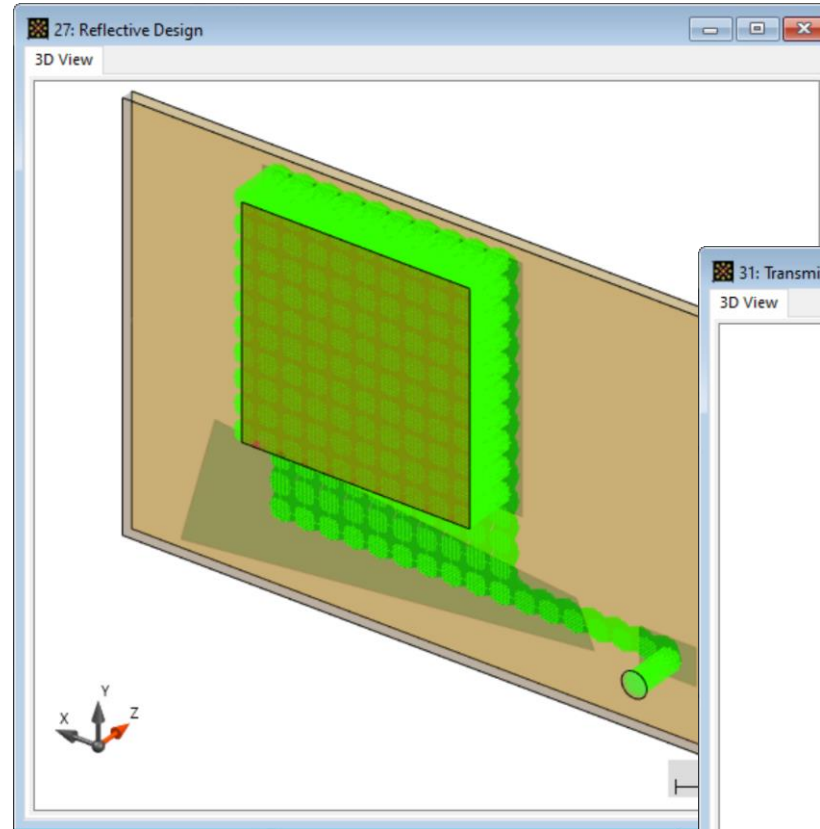
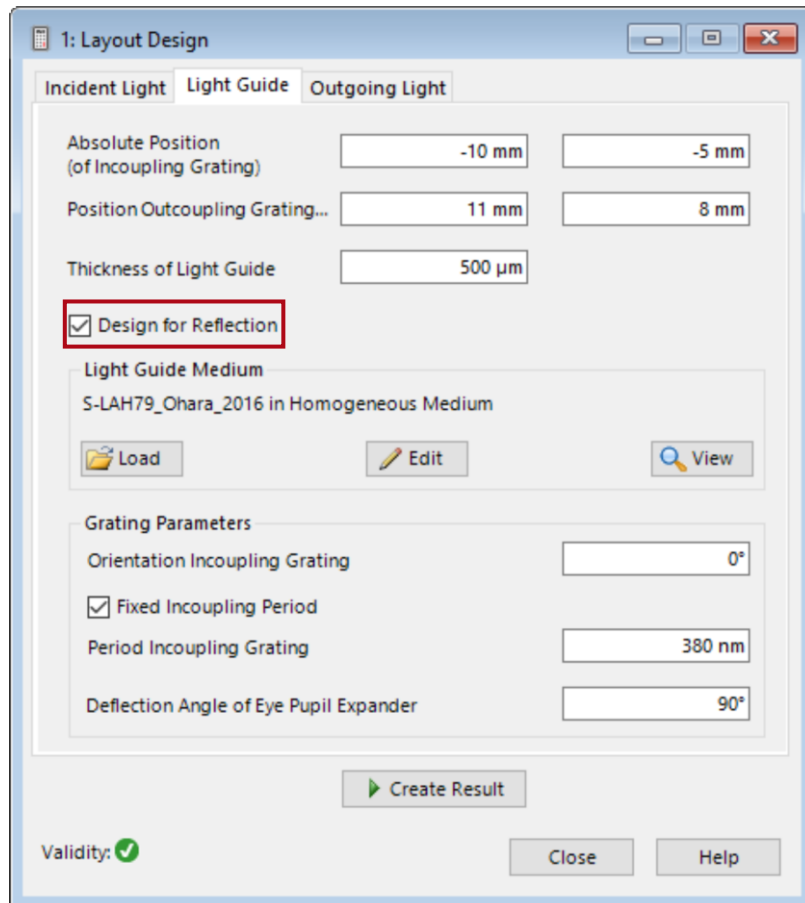
Fixed Incoupling Period

Period Incoupling Grating

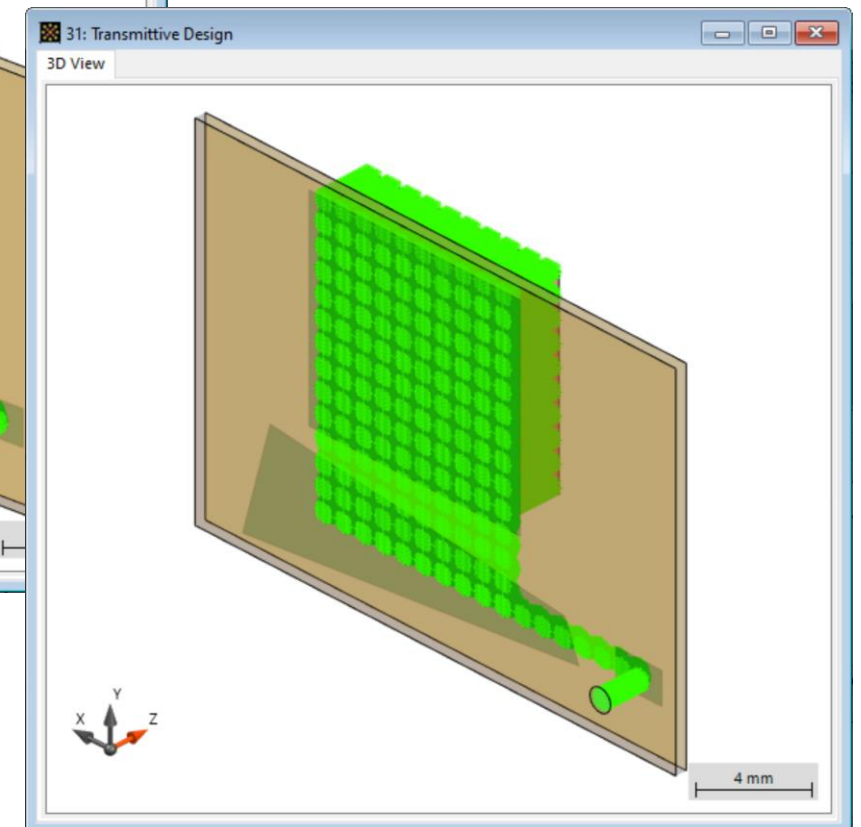
Deflection Angle of Eye Pupil Expander

Validity:

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

Edit Grating Region

Shape Region Channels Grating

Spectral Domain

Definition of Unrotated Rectangle

Center X: -10 mm Center Y: -5 mm

Width: 2.816 mm Height: 1.669 mm

Keep Aspect Ratio

Validity:

Rotation Angle: 0°

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
3	Outcoupling Grating	Rectangular Region	380 nm

Apply Absorption Outside of Region on Surface

OK Cancel Help

1: Layout Design

Incident Light Light Guide Outgoing Light

Absolute Position (of Incoupling Grating): -10 mm -5 mm

Position Outcoupling Grating...: 11 mm 8 mm

Thickness of Light Guide: 500 μm

Design for Reflection

Light Guide Medium: S-LAH79_Ohara_2016 in Homogeneous Medium

Grating Parameters

Orientation Incoupling Grating: 0°

Fixed Incoupling Period

Period Incoupling Grating: 380 nm

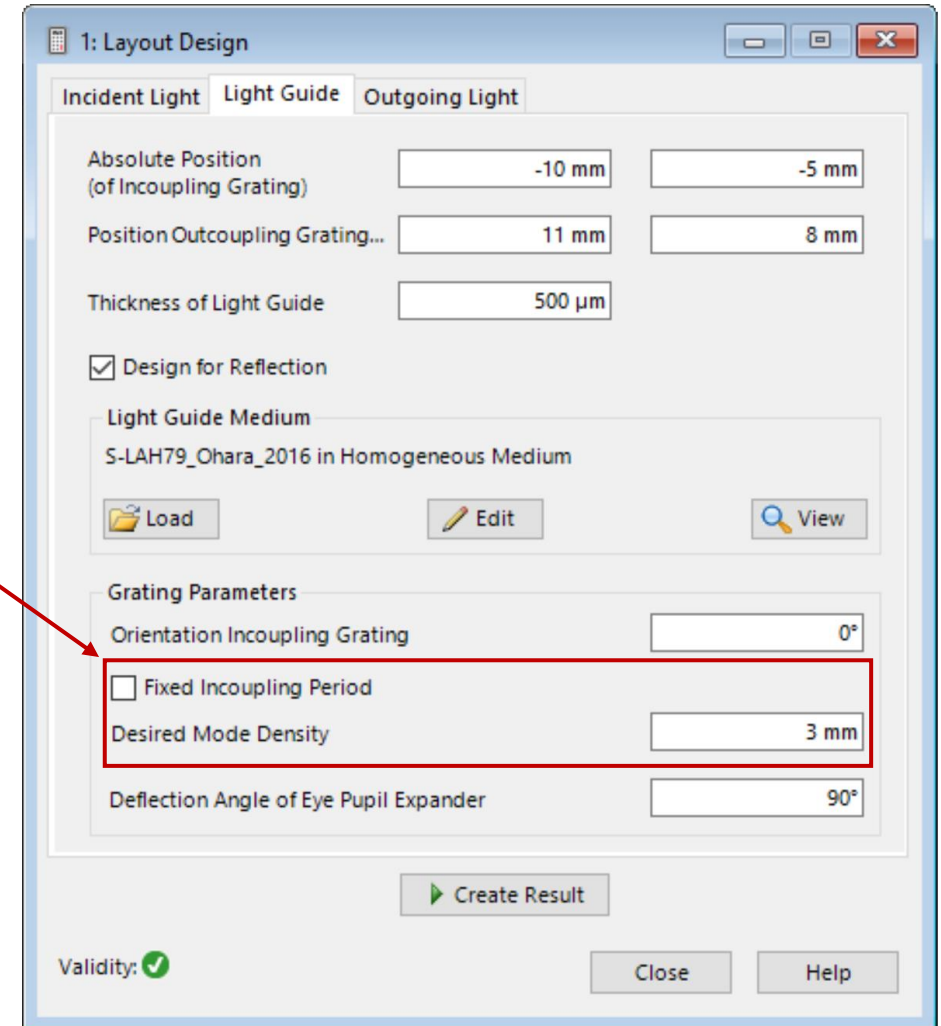
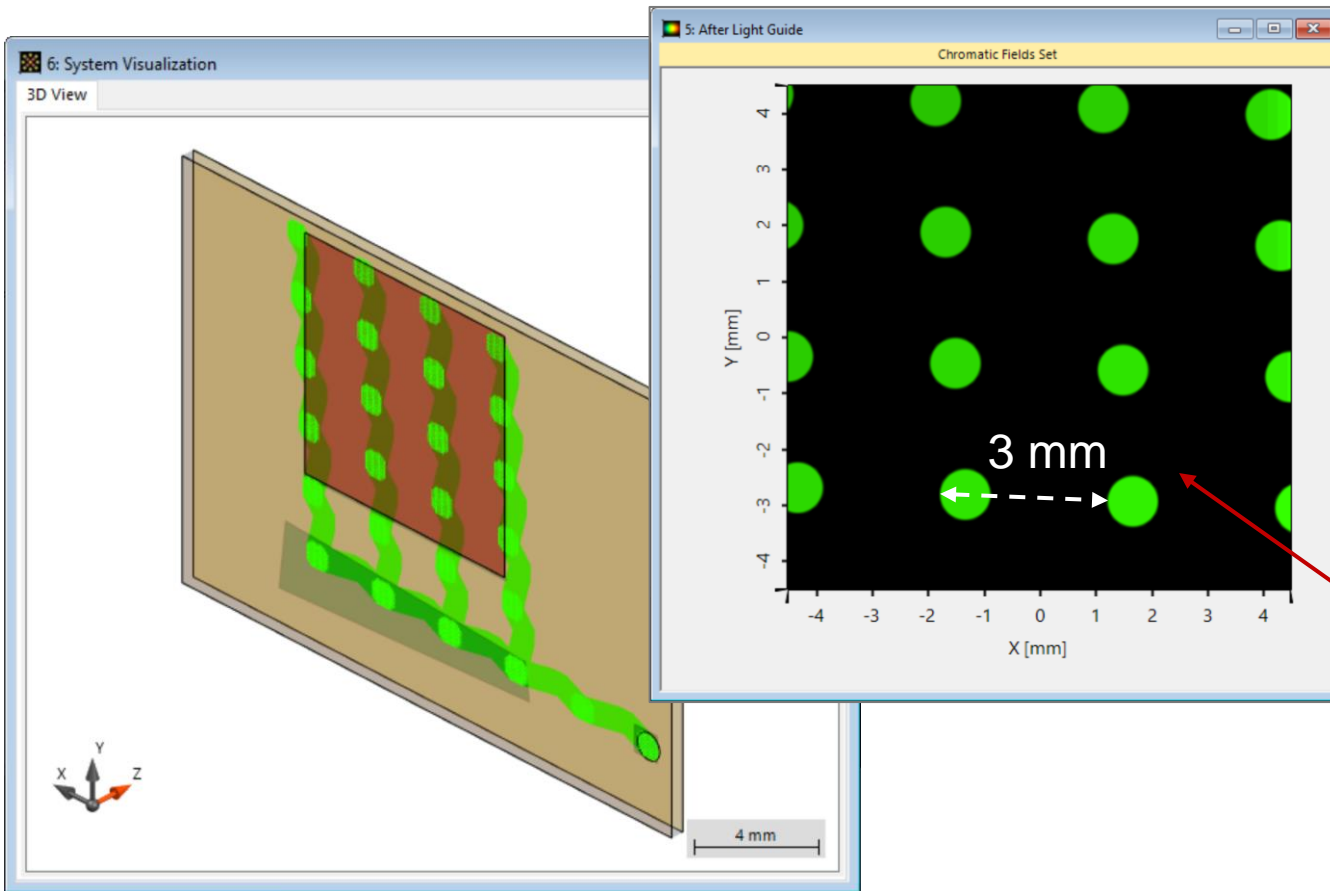
Deflection Angle of Eye Pupil Expander: 90°

Create Result

Validity: Close Help

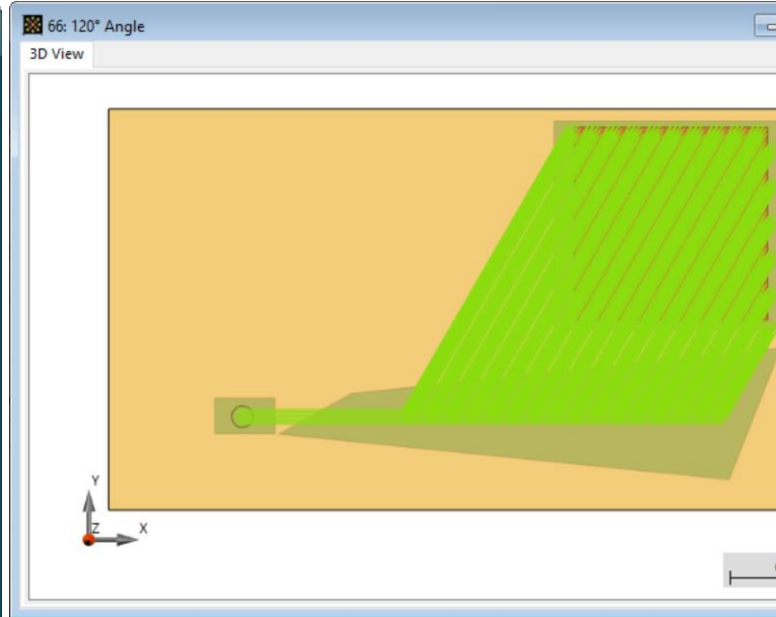
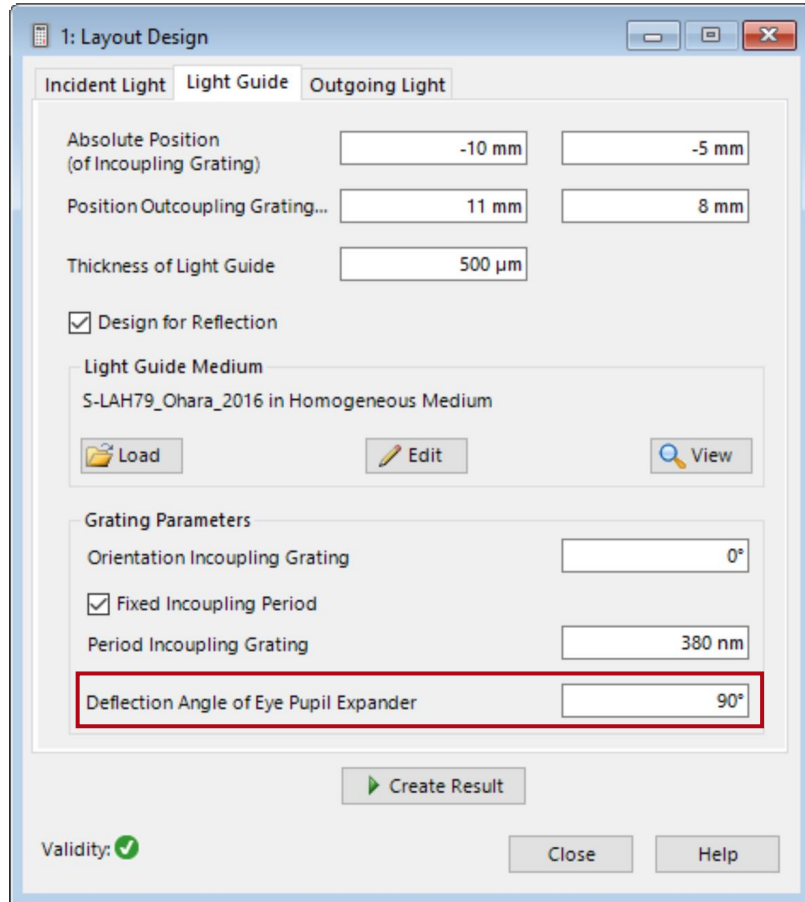
The period of the expansion grating is automatically calculated.

Parameters of Grating Regions

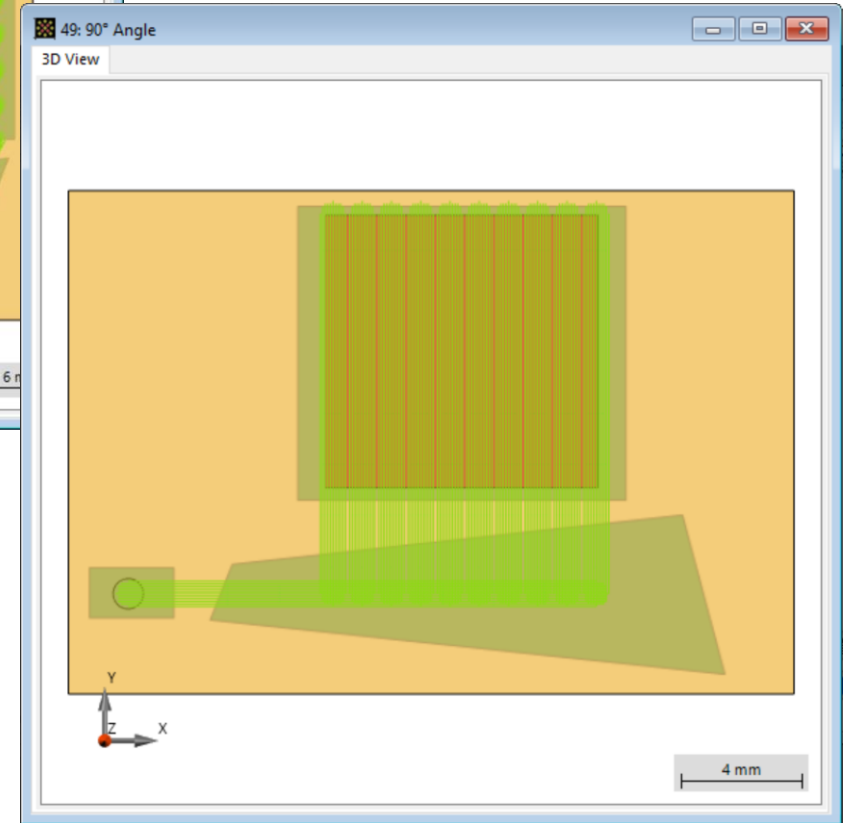


Instead of defining a period for the incoupling grating, a (minimum) *desired mode density* in the eye box can be specified. This value is used to estimate an adequate period of the incoupler.

Deflection Angle Setting



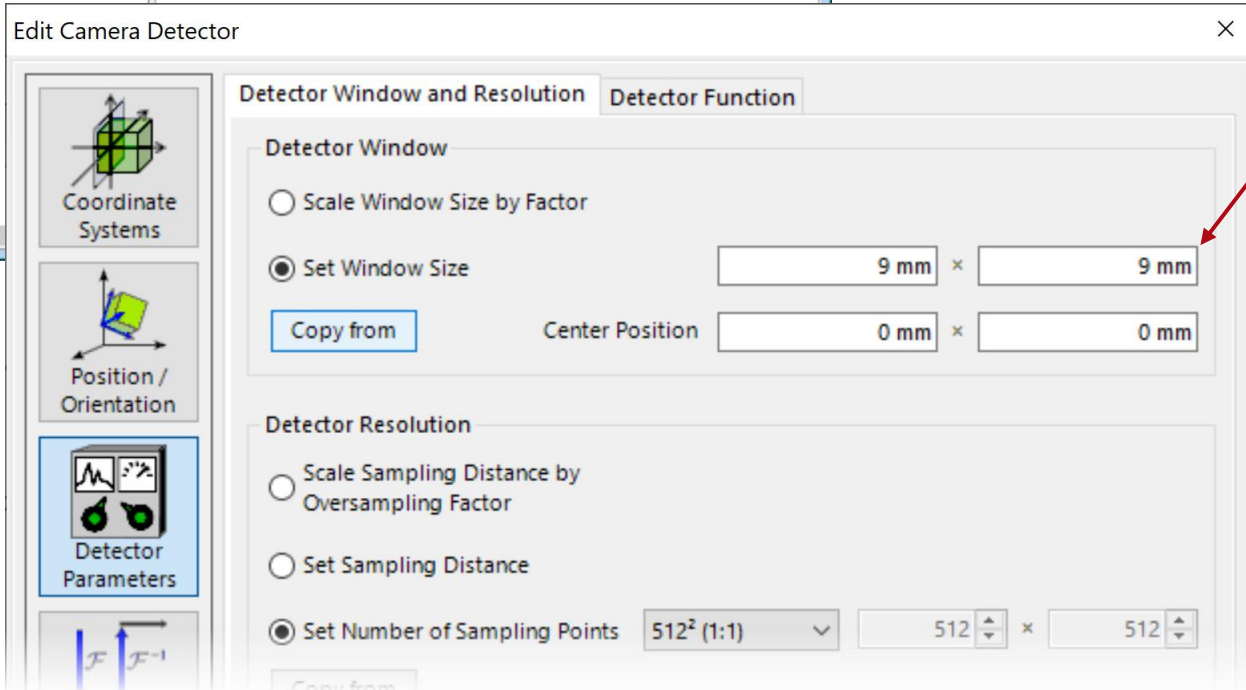
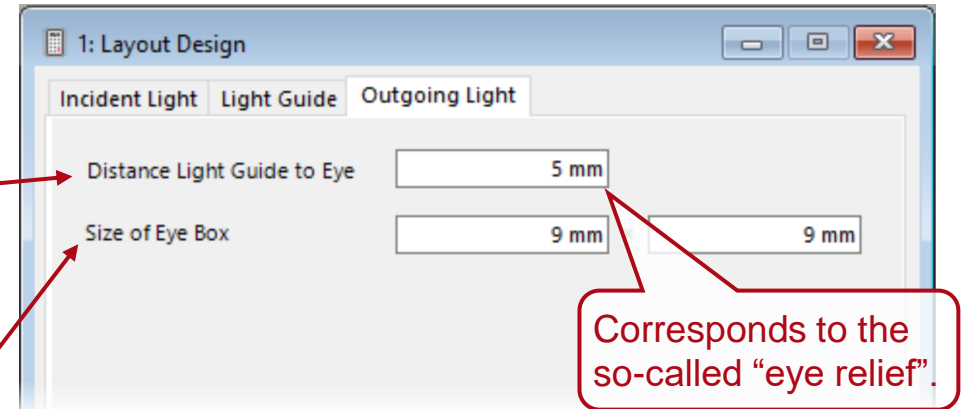
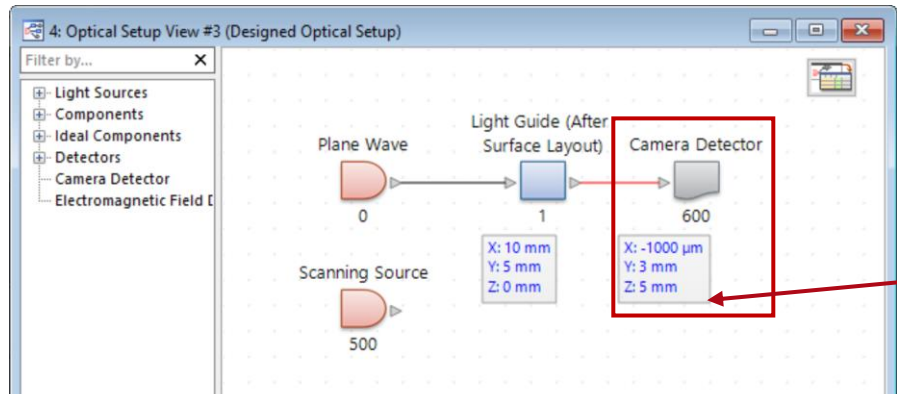
120° (Note: Position Outcoupling Grating has been set to 19mm in x-direction and 9mm in y-direction to avoid overlap of the regions)



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

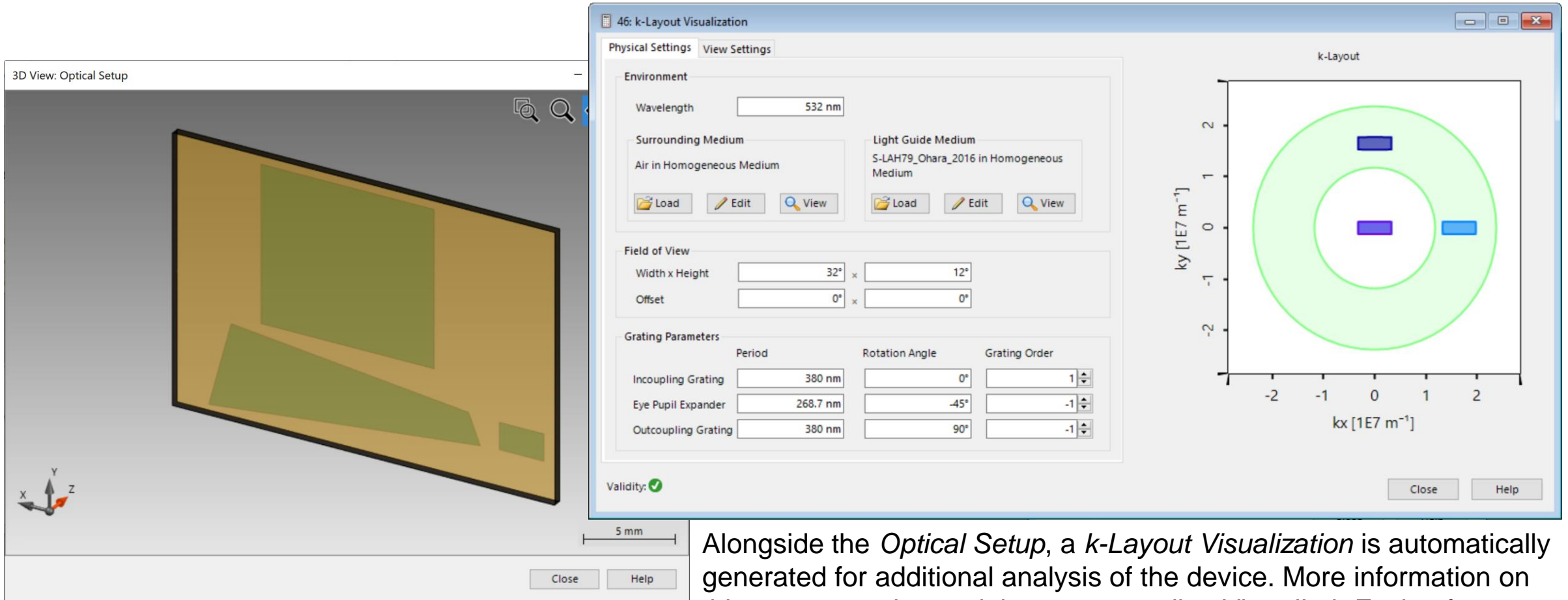


The position and window size of the detector (*Camera Detector* by default) are specified by the settings in the tool. Additional parameters like sampling can be adjusted by the user if needed. It is also possible to add additional detectors into the system after the layout design process has completed.

Overview of Parameter Dependencies and Contributions

Parameter in Light Guide	Calculated from:
Size of incoupler	<i>Beam Size, Distance Source to Light Guide, FOV</i>
Period of incoupler	<ul style="list-style-type: none"> <i>Period Incoupling Grating</i> <i>Desired Mode Density, Wavelength, Distance Source to Light Guide, Thickness of Light Guide</i>
Size of outcoupler	<i>Size eye box, Thickness of Light Guide, Distance Light Guide to Eye, FOV, Beam Size</i>
Period of outcoupler	<ul style="list-style-type: none"> <i>Period Incoupling Grating</i> <i>Desired Mode Density, Wavelength, Distance Source to Light Guide, Thickness of Light Guide</i>
Shape of Eye Pupil Expander	<i>Deflection Angle of Eye Pupil Expander, position of incoupler and outcoupler, Beam Size</i>
Period of Eye Pupil Expander	<i>Deflection Angle of Eye Pupil Expander, Wavelength, period of incoupler, FOV, Beam Size</i>

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	<ul style="list-style-type: none">- <u>k-Domain Layout Visualization</u>- <u>Construction of a Light Guide</u>- <u>Modeling of a “HoloLens 1”-Type Layout with Light Guide Component</u>- <u>Flexible Region Definition</u>- <u>Specification of Diffraction Orders and Efficiencies for Grating Regions</u>- <u>Light Guide Design Tool</u>