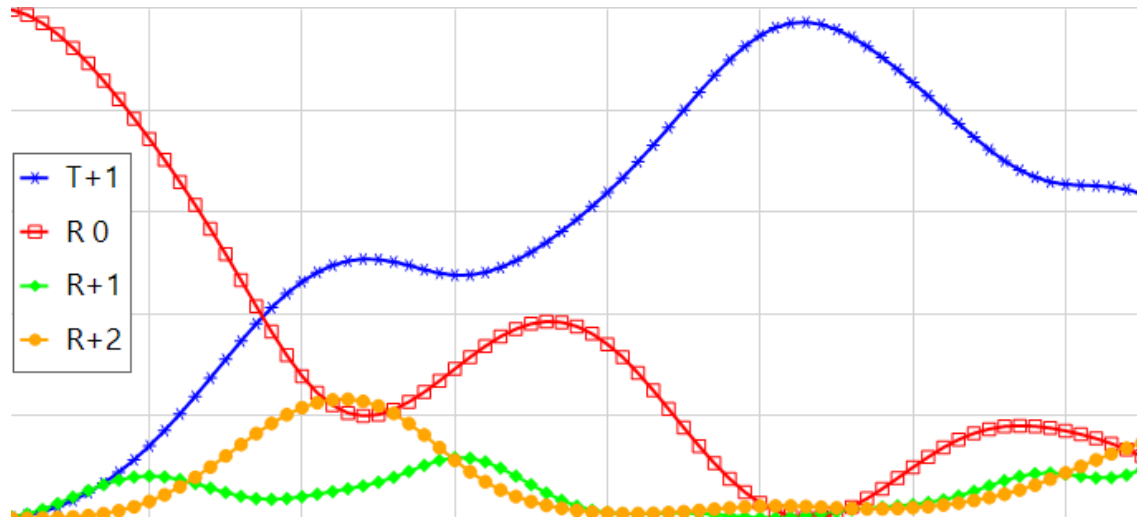


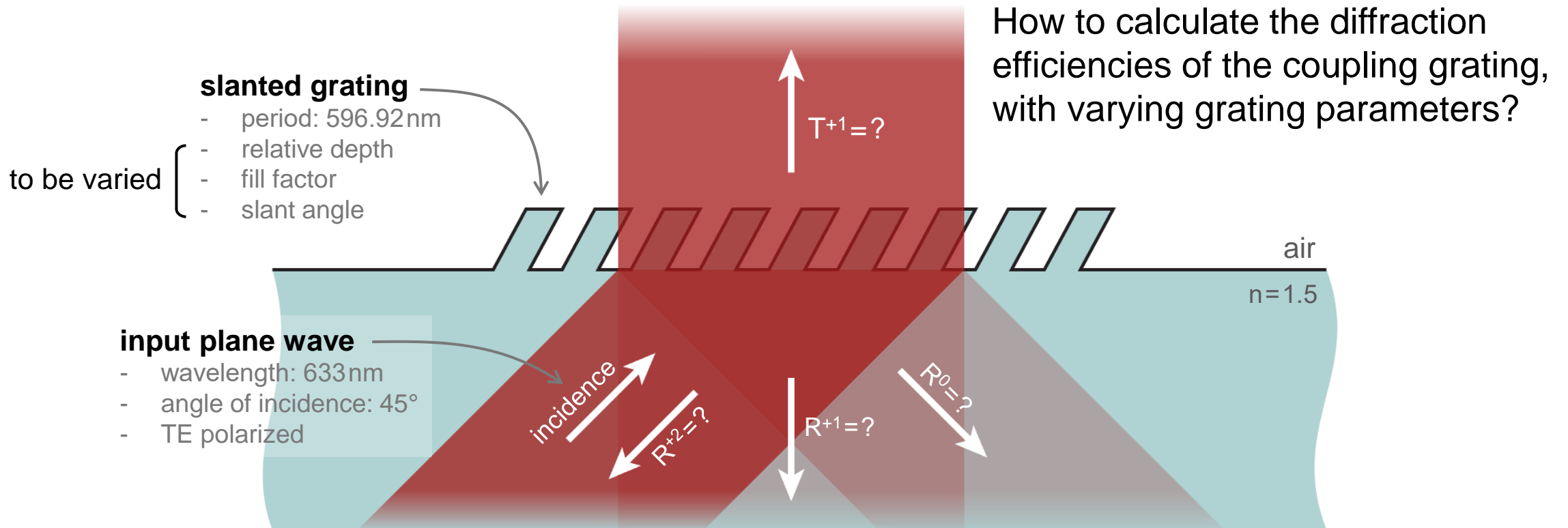
Analysis of Slanted Gratings for Lightguide Coupling

Abstract

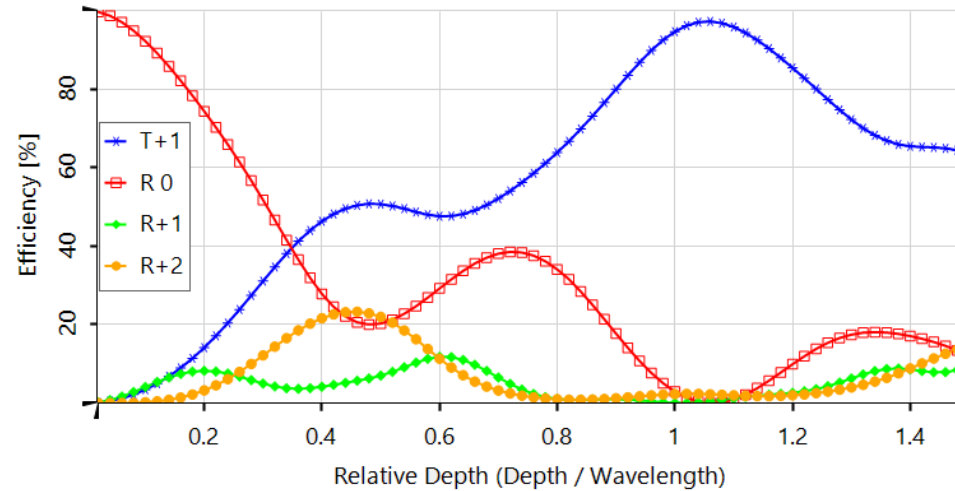
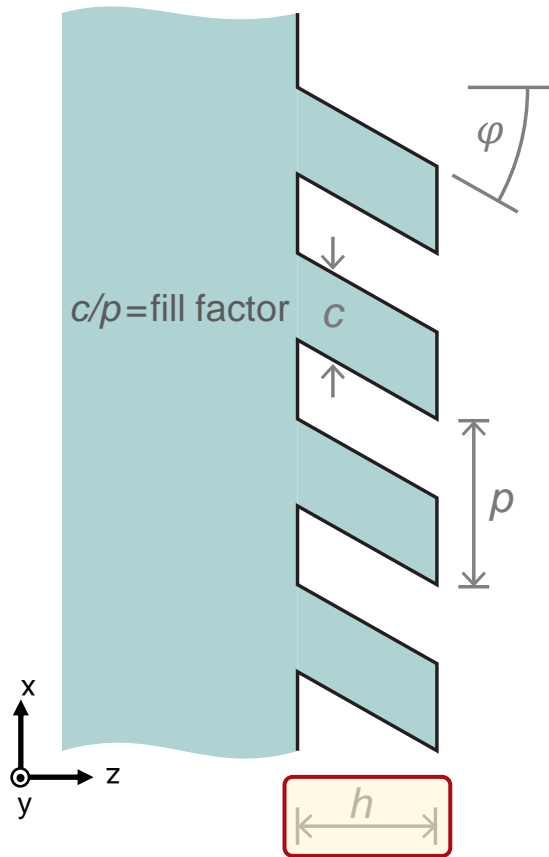


Slanted gratings are commonly used for coupling light into optical lightguides due to their high efficiency in a certain diffraction order. Nowadays, they are often applied in augmented and mixed reality applications. We show how VirtualLab Fusion can be used to analyze certain slanted grating geometries from literature, with specific parameters like slant angle, fill factor, and modulation depth. In addition, the effect of different incidence angles on the diffraction efficiency is investigated.

Modeling Task



Diffraction Efficiency vs Relative Depth



Grating Parameter Value & Unit

| | |
|----------------------------|---------------------|
| relative depth h/λ | to be varied |
| slant angle φ | -30° |
| fill factor c/p | 50% |

simulation by Fourier modal method (FMM), also known as rigorous coupled-wave analysis (RCWA), in VirtualLab Fusion

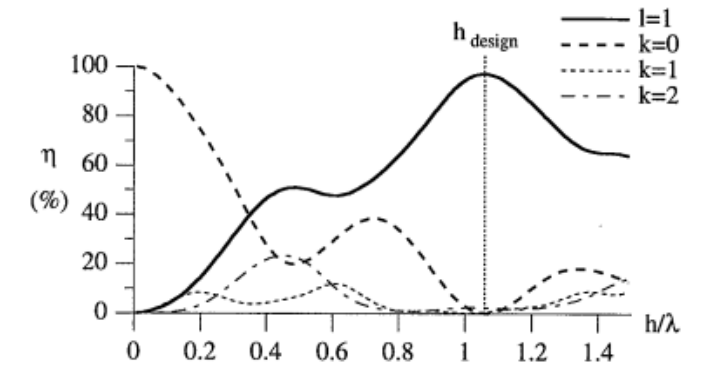
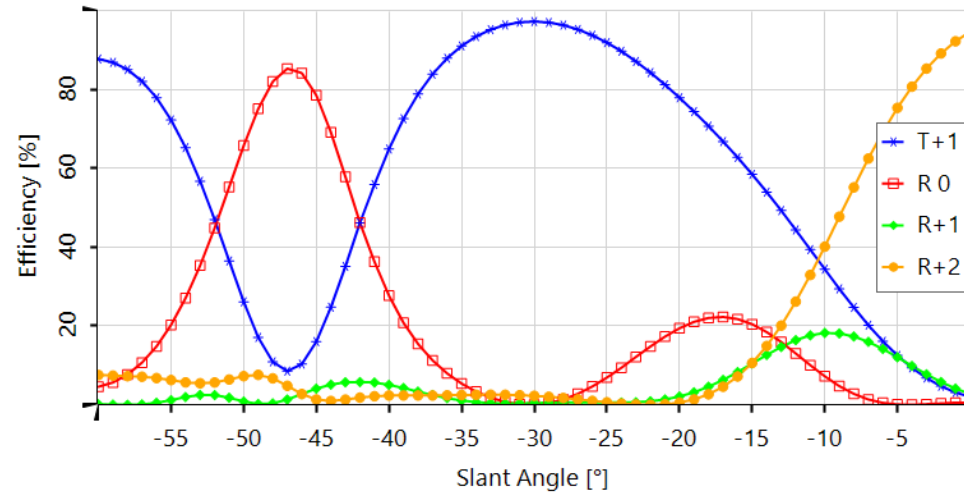
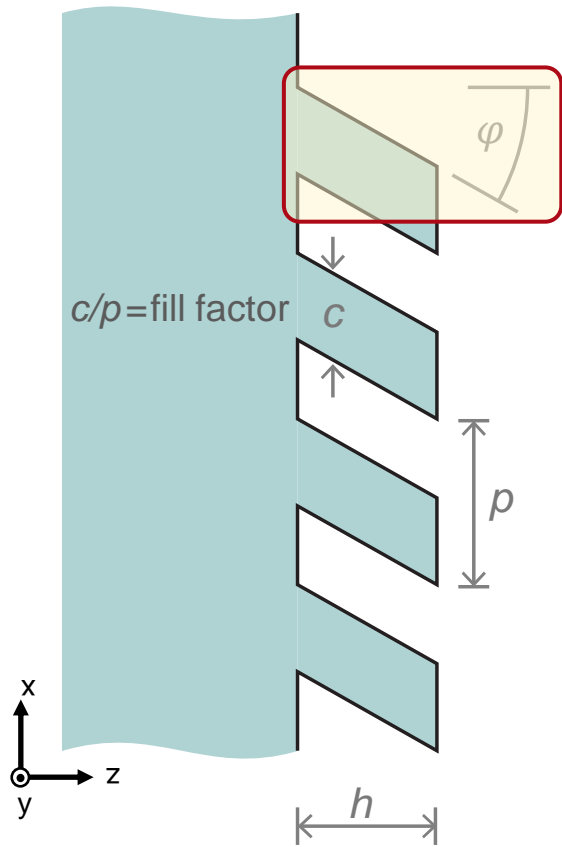


Figure from J. Michael Miller, *et al.*, Appl. Opt. 36, 5717-5727 (1997)

Diffraction Efficiency vs Slant Angle



simulation by Fourier modal method (FMM), also known as rigorous coupled-wave analysis (RCWA), in VirtualLab Fusion

| Grating Parameter | Value & Unit |
|----------------------------|---------------------|
| relative depth h/λ | 1.058 |
| slant angle φ | to be varied |
| fill factor c/p | 50% |

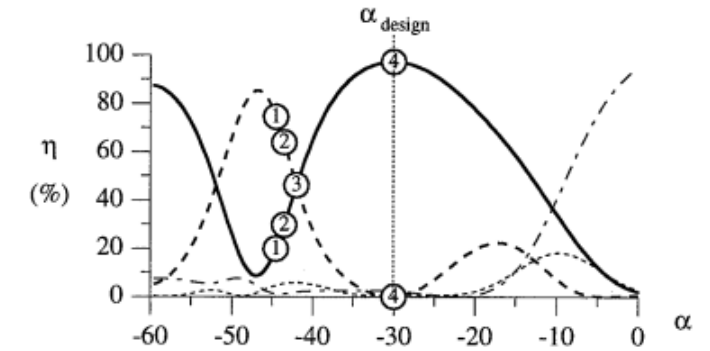
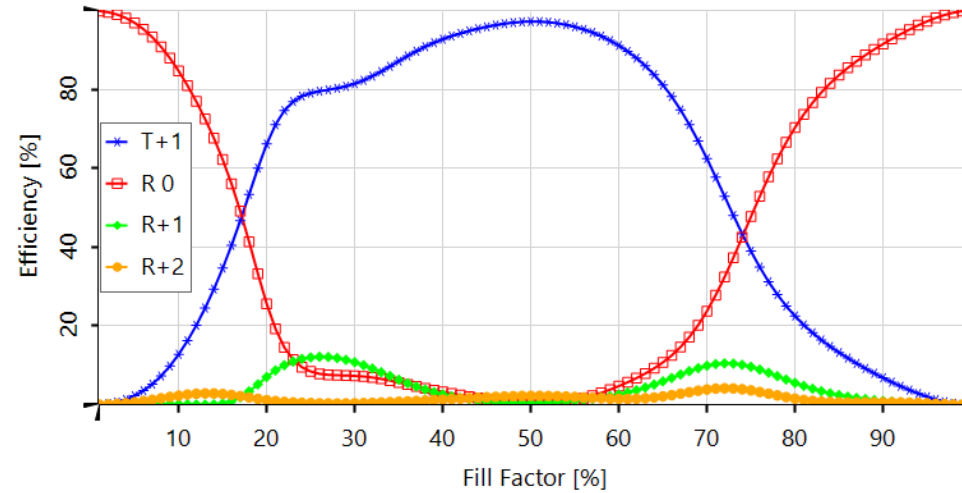
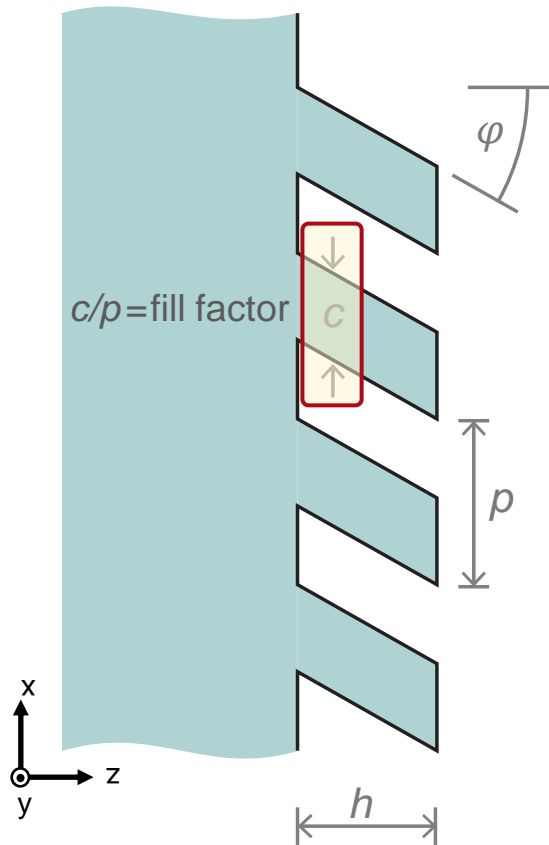


Figure from J. Michael Miller, *et al.*, Appl. Opt. 36, 5717-5727 (1997)

Diffraction Efficiency vs Fill Factor



| Grating Parameter | Value & Unit |
|----------------------------|---------------------|
| relative depth h/λ | 1.058 |
| slant angle φ | -30° |
| fill factor c/p | to be varied |

simulation by Fourier modal method (FMM), also known as rigorous coupled-wave analysis (RCWA), in VirtualLab Fusion

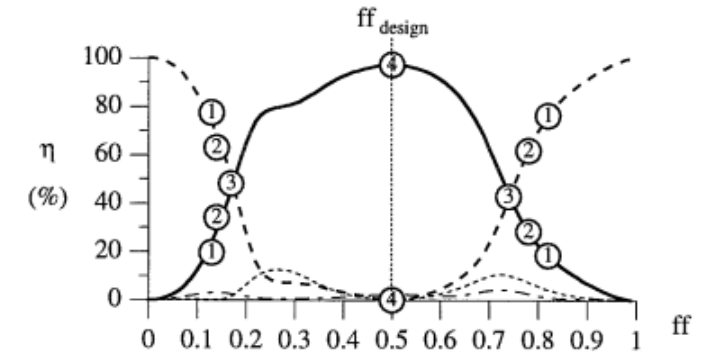
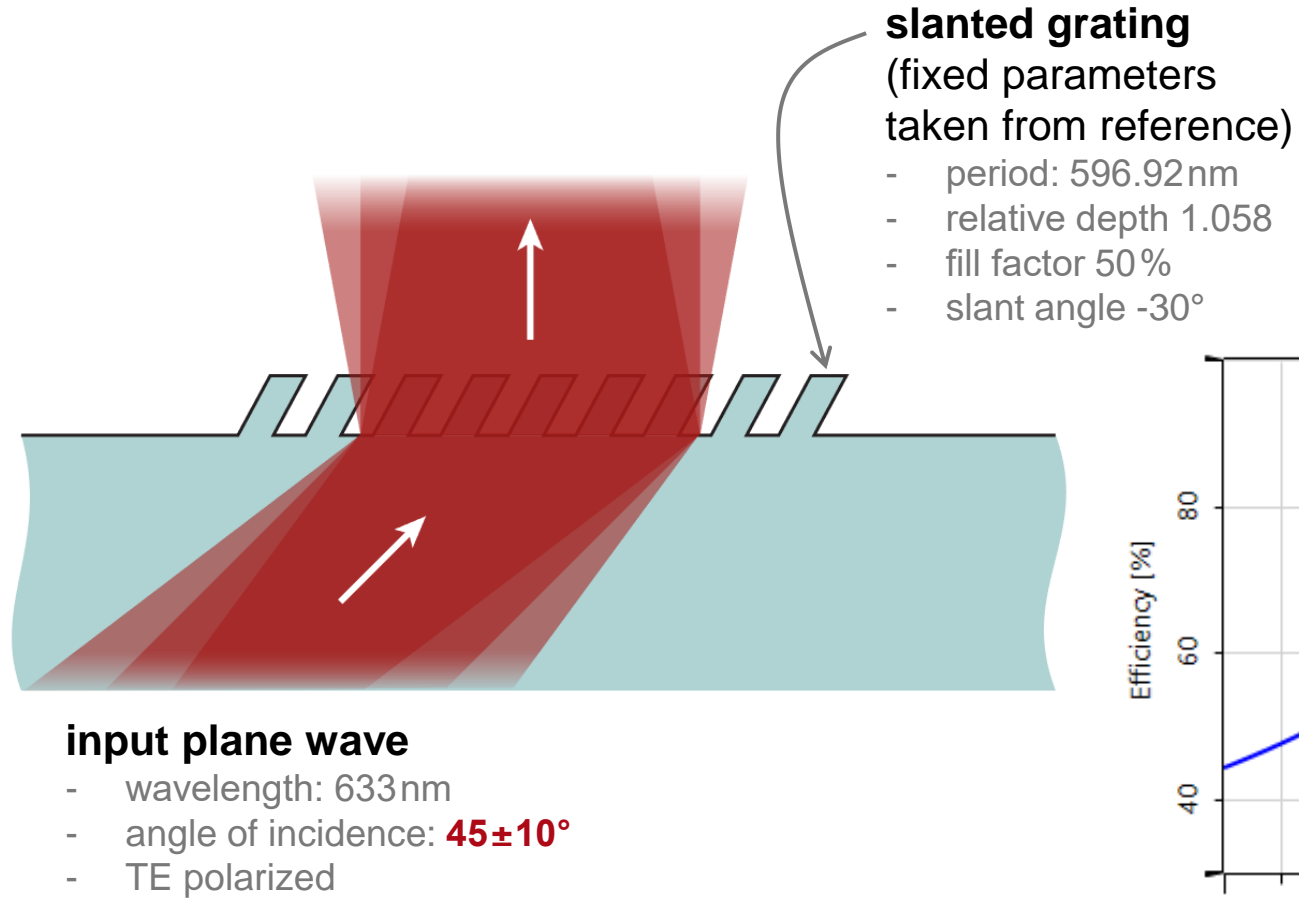
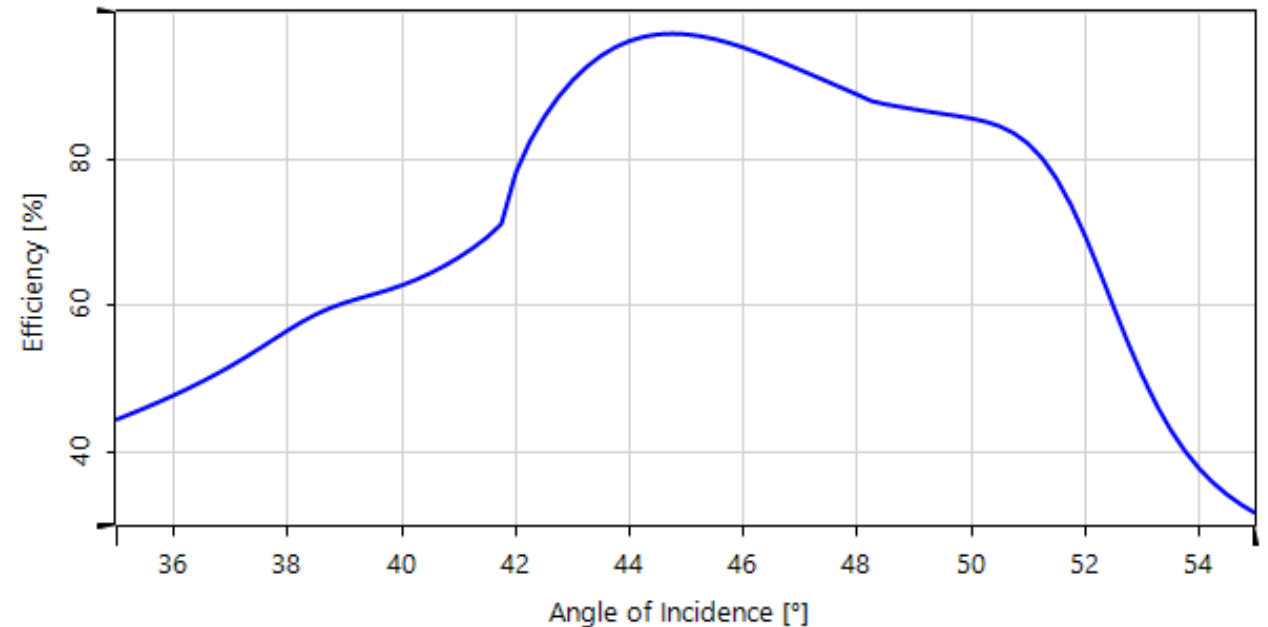


Figure from J. Michael Miller, *et al.*, Appl. Opt. 36, 5717-5727 (1997)

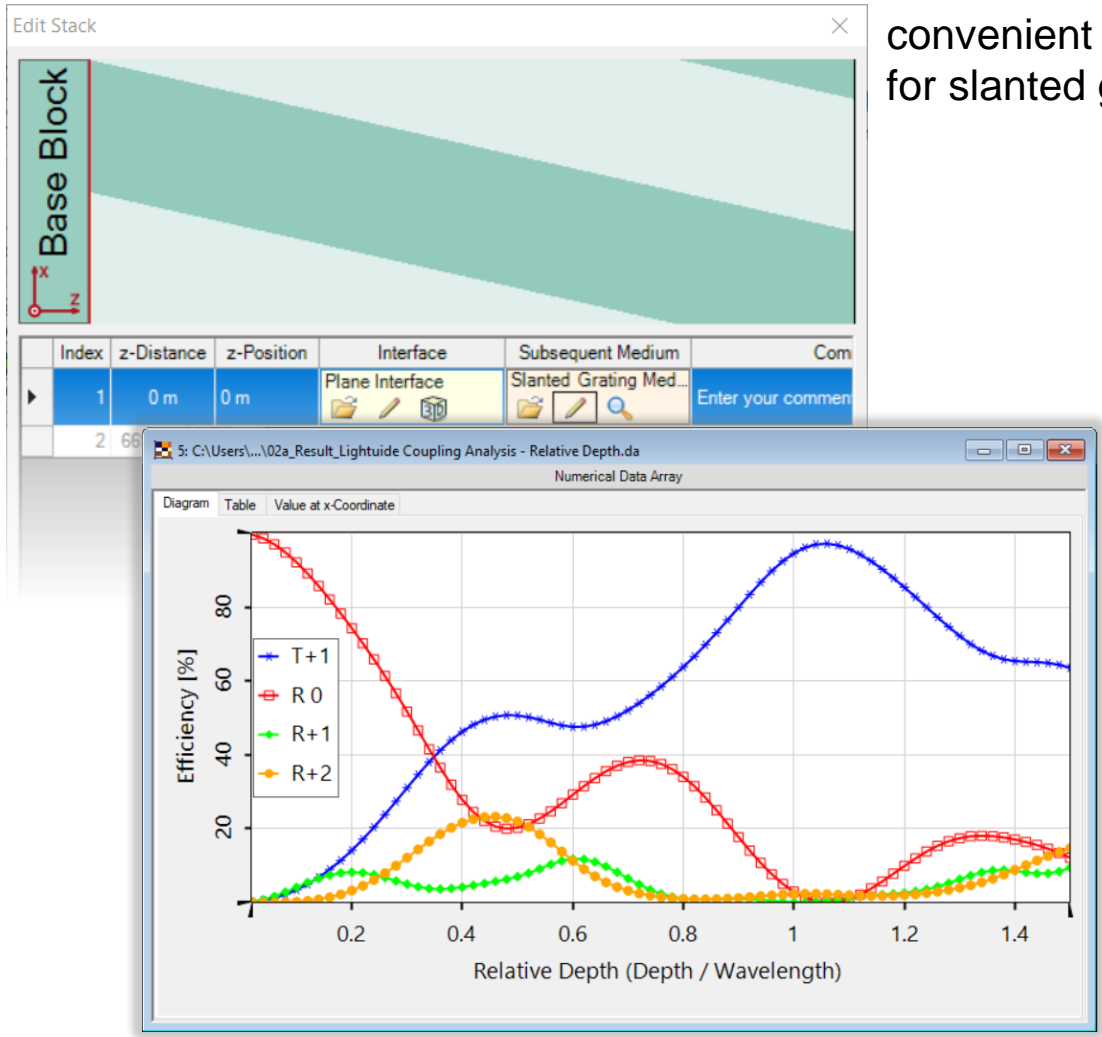
Diffraction Efficiency vs Angle of Incidence



Grating diffraction efficiency is usually sensitive to the angle of incidence.



Peek into VirtualLab Fusion



convenient definition for slanted gratings

The 'Edit Parameter Coupling' dialog box is shown. It has a 'Parameter Specification' section with a 'Filter by...' field and a 'Show Only Used Parameters' checkbox. Below this is a table with columns: Index, Object, Category, Parameter, Use in Snippet, and Short Name. The table contains two rows: Row 1 with Object '*Ideal Plane...', Category, Parameter 'Wavelength', Use in Snippet checked, and Short Name 'Wavelength'; Row 2 with Object '*Slanted Grat...', Category 'Stack #2 (Slant...', Parameter 'Medium #1 (Slanted Grating...', Use in Snippet checked, and Short Name 'z-Extension'. The 'Wavelength' and 'z-Extension' cells are highlighted with a red box. At the bottom are 'Help', 'Validity: ✓', '< Back', 'Next >', and 'Finish' buttons.

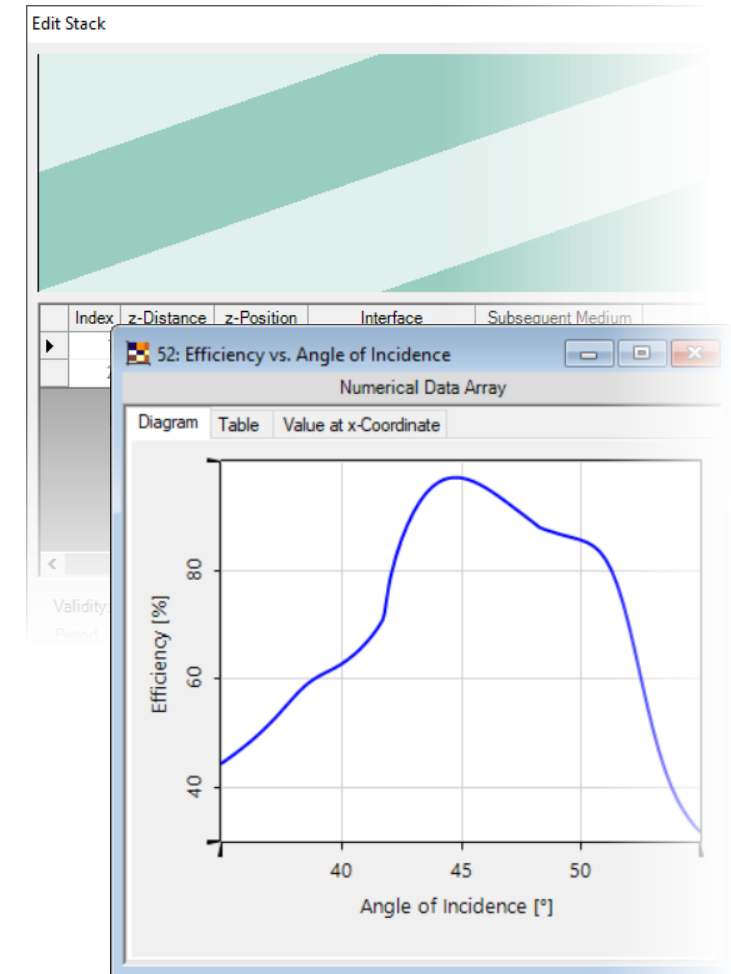
The 'Snippet Specification' dialog box is shown. It has an 'Edit' button and a 'Validity: ✓' indicator. Below this is a text input field labeled 'RelativeDepth' with a value of '0.1'. Below the input field is the equation:
$$\text{Relative Depth} = z\text{-Extension} / \text{Wavelength}$$
 with a 'Help' button. At the bottom are 'Help', 'Validity: ✓', '< Back', 'Next >', and 'Finish' buttons.

convenient coupling of parameters

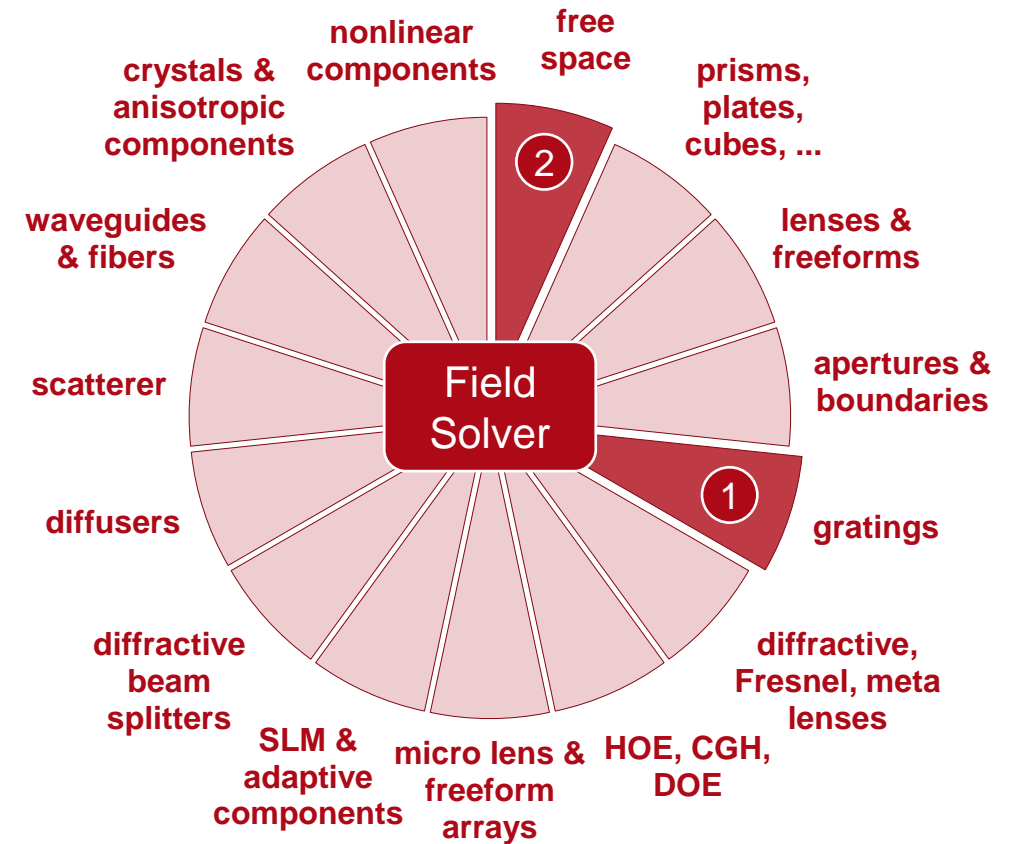
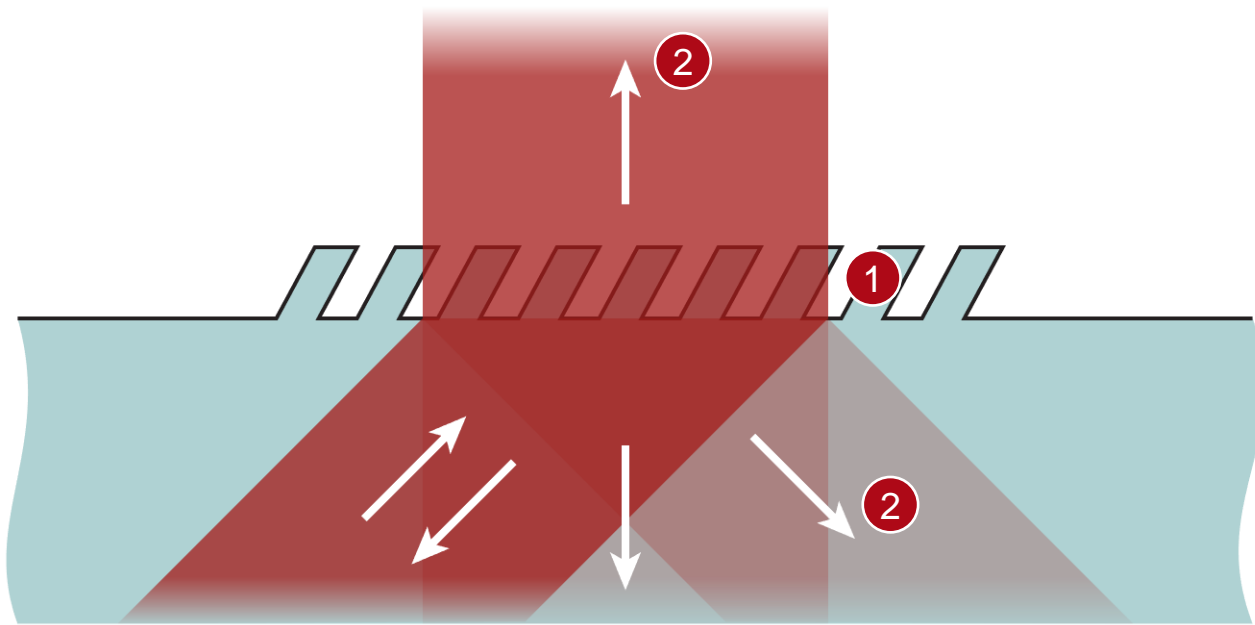
rigorous diffraction efficiency calculation and visualization

Workflow in VirtualLab Fusion

- Configuration of lightguide coupling grating structure
 - [Advanced Configuration of Slanted Grating](#) [Use Case]
 - [Configuration of Grating Structures by Using Special Media](#) [Use Case]
 - [Configuration of Grating Structures by Using Interfaces](#) [Use Case]
- Analyze coupling grating diffraction efficiency
 - [Customized Detector for Lightguide Coupling Grating Evaluation](#) [Use Case]
- Check efficiency by scanning over specific parameter
 - [Usage of Parameter Run](#) [Use Case]



VirtualLab Fusion Technologies



Document Information

| | |
|------------------|---|
| title | Analysis of Slanted Gratings for Lightguide Coupling |
| document code | GRT.0009 |
| document version | 3.0 |
| software version | 2021.1 (Build 1.180) |
| software edition | VirtualLab Fusion Advanced |
| category | Application Use Case |
| further reading | <ul style="list-style-type: none">- <u>Parametric Optimization and Tolerance Analysis of Slanted Gratings</u>- <u>Configuration of Grating Structures by Using Special Media</u> |