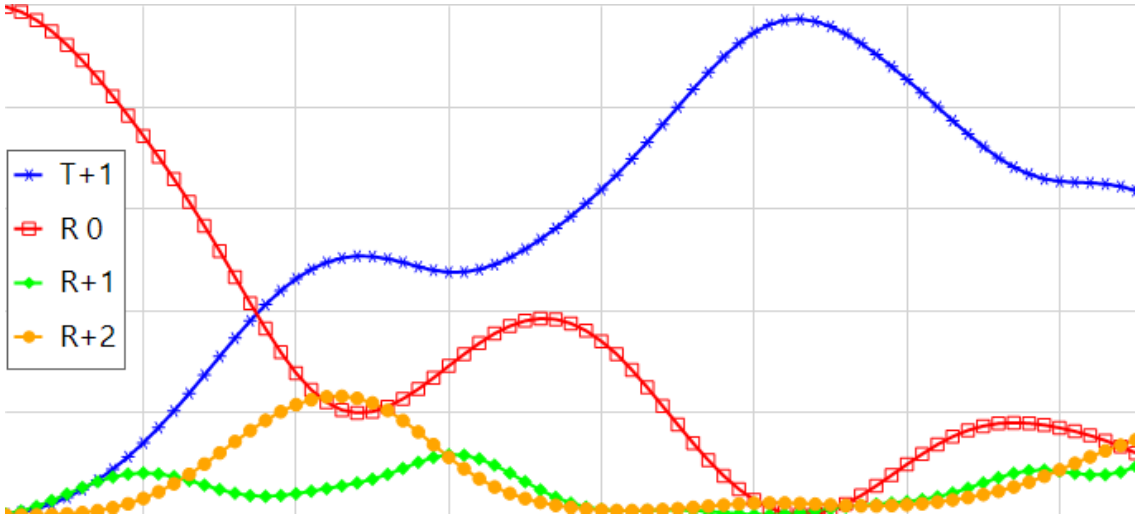
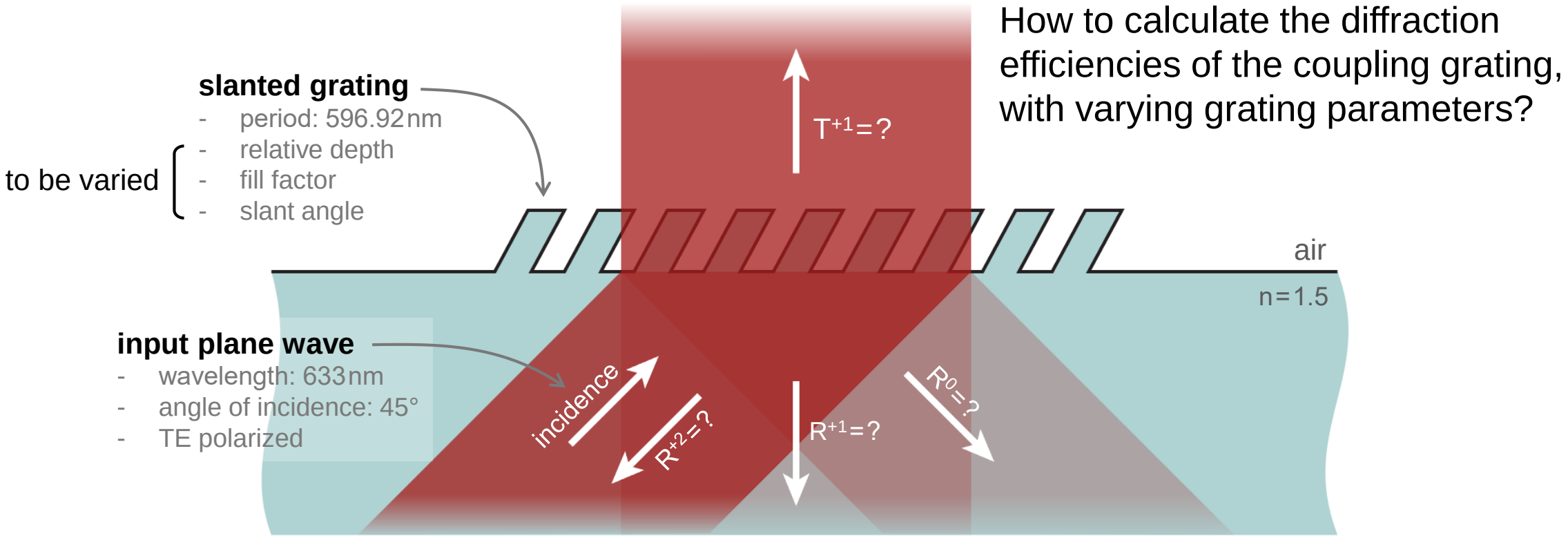
Analysis of Slanted Gratings for Lightguide Coupling

Abstract



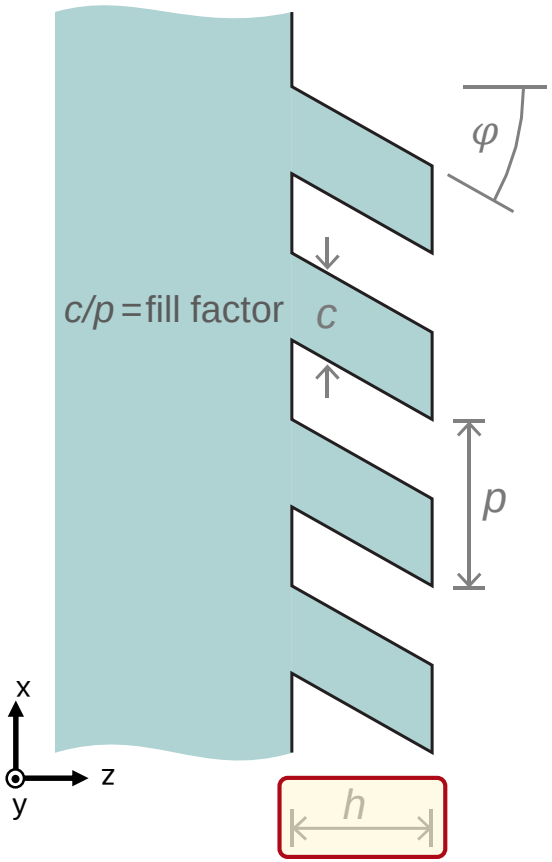
Slanted gratings are commonly used for coupling light into optical lightguides due to their high efficiency in a certain diffraction order. Nowadays, they are often applied in the augmented and mixed reality applications. It will be shown how VirtualLab Fusion can be used to analyze certain slanted grating 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.

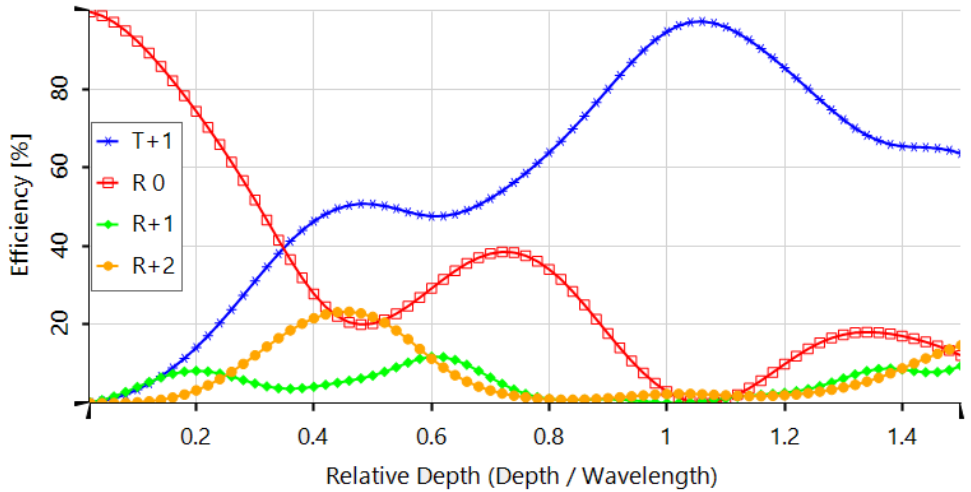
Modeling Task



How to calculate the diffraction efficiencies of the coupling grating, with varying grating parameters?

Diffraction Efficiency vs. Relative Depth





simulation by Fourier modal method (FMM), also known as RCWA, in VirtualLab Fusion

Grating Parameter	Value & Unit
relative depth	**to be varied**
slant angle φ	-30°
fill factor c/p	50%

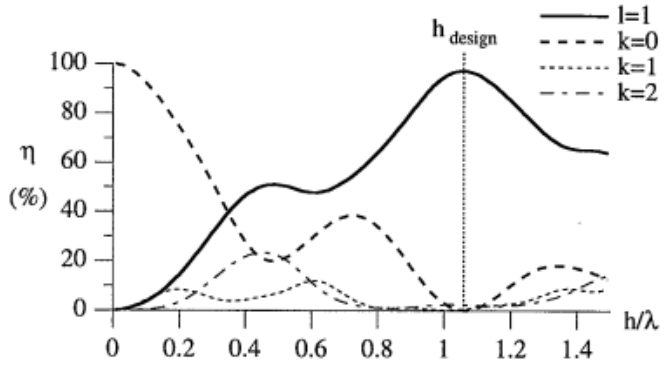
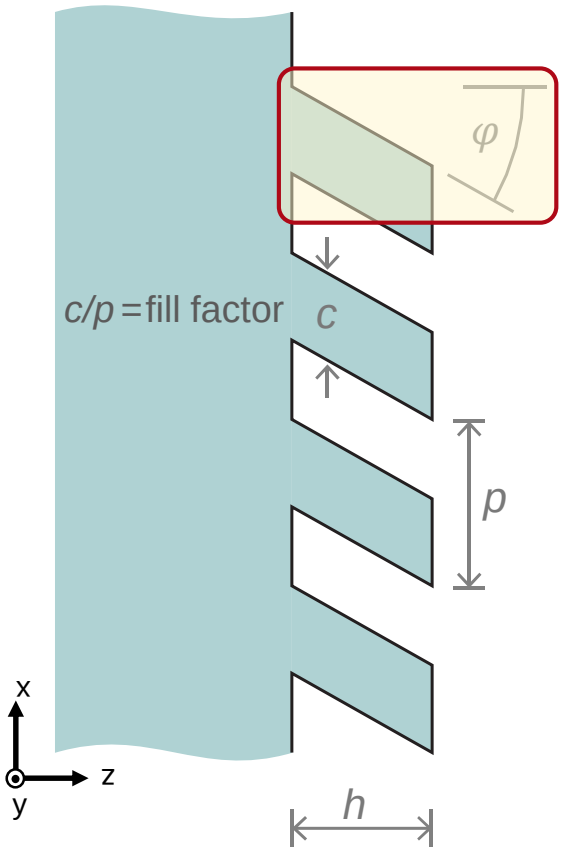
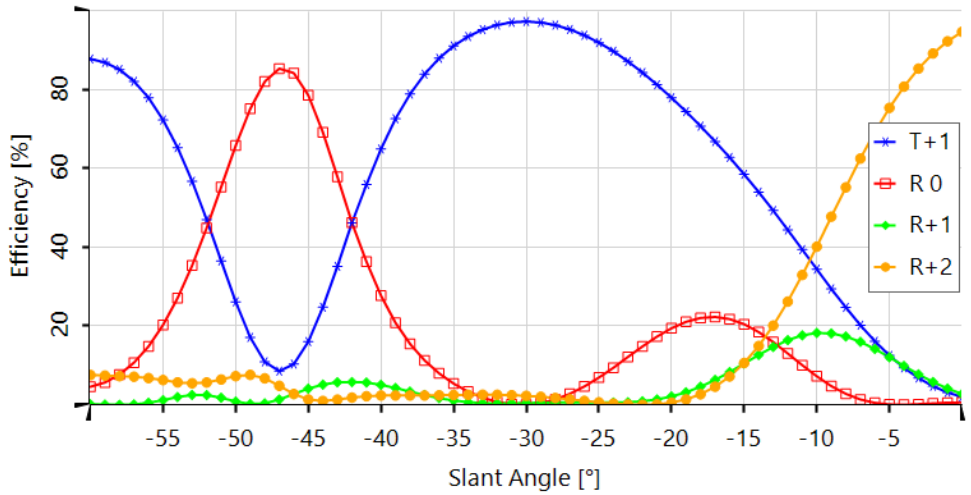


Figure from J. Michael Miller, *et al.*, Appl. Opt. 36, 5717-5727 (1997)

Diffraction Efficiency vs. Slant Angle





simulation by Fourier modal method (FMM), also known as RCWA, in VirtualLab Fusion

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

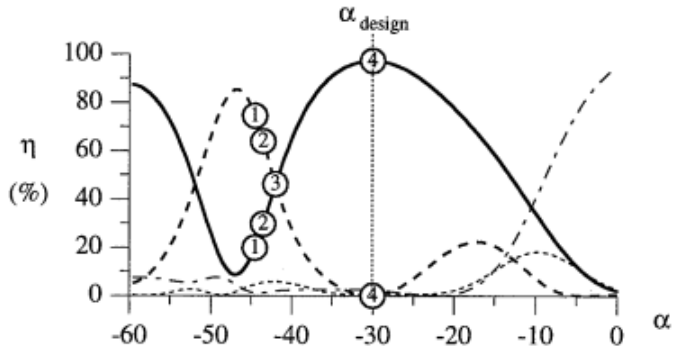
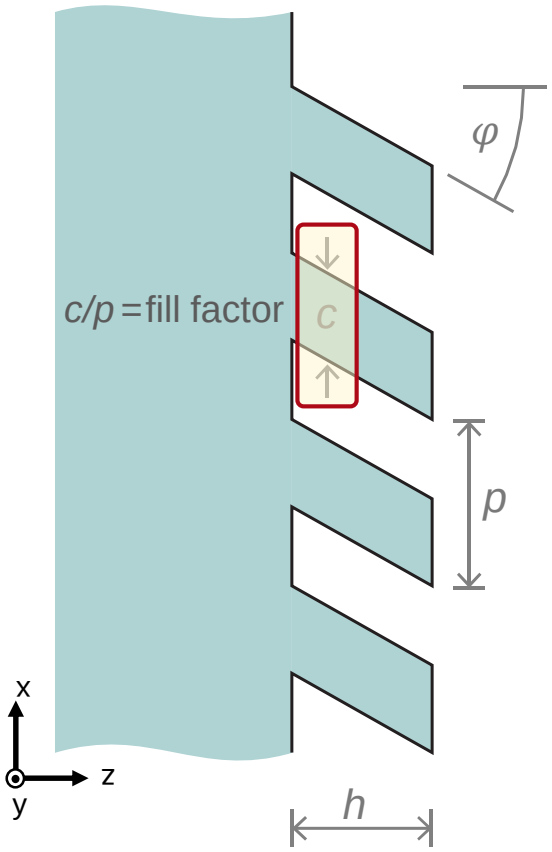
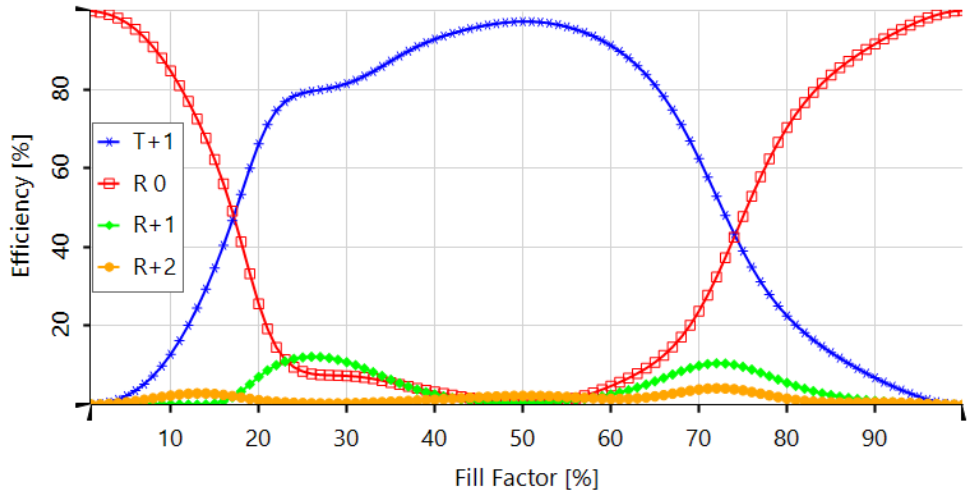


Figure from J. Michael Miller, *et al.*, Appl. Opt. 36, 5717-5727 (1997)

Diffraction Efficiency vs. Fill Factor





simulation by Fourier modal method (FMM), also known as RCWA, in VirtualLab Fusion

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

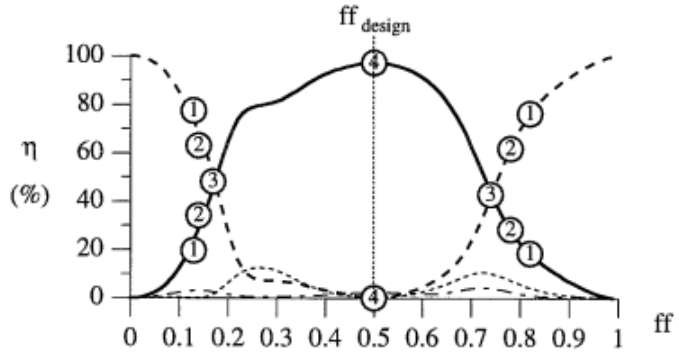
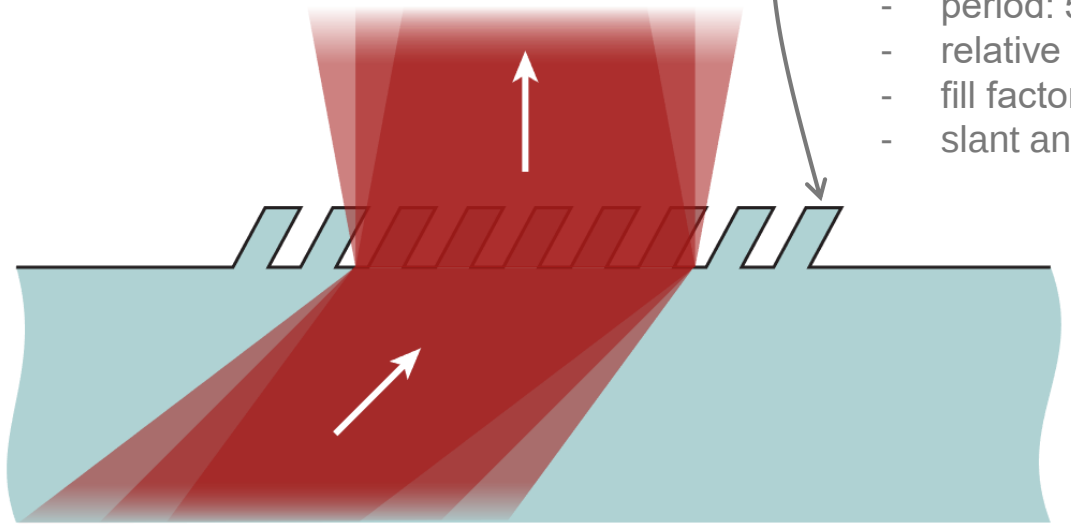


Figure from J. Michael Miller, *et al.*, Appl. Opt. 36, 5717-5727 (1997)

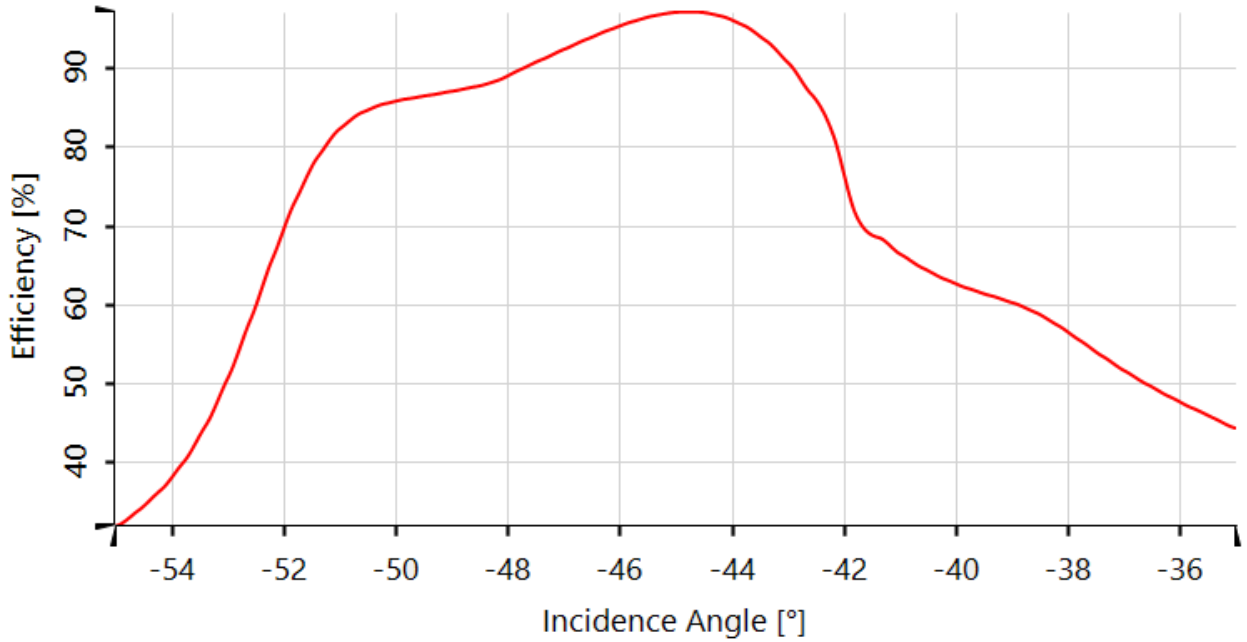
Diffraction Efficiency vs. Varying Incidence Angle



slanted grating
(fixed parameters
taken from reference)
- period: 596.92nm
- relative depth 1.058λ
- fill factor 50%
- slant angle -30°

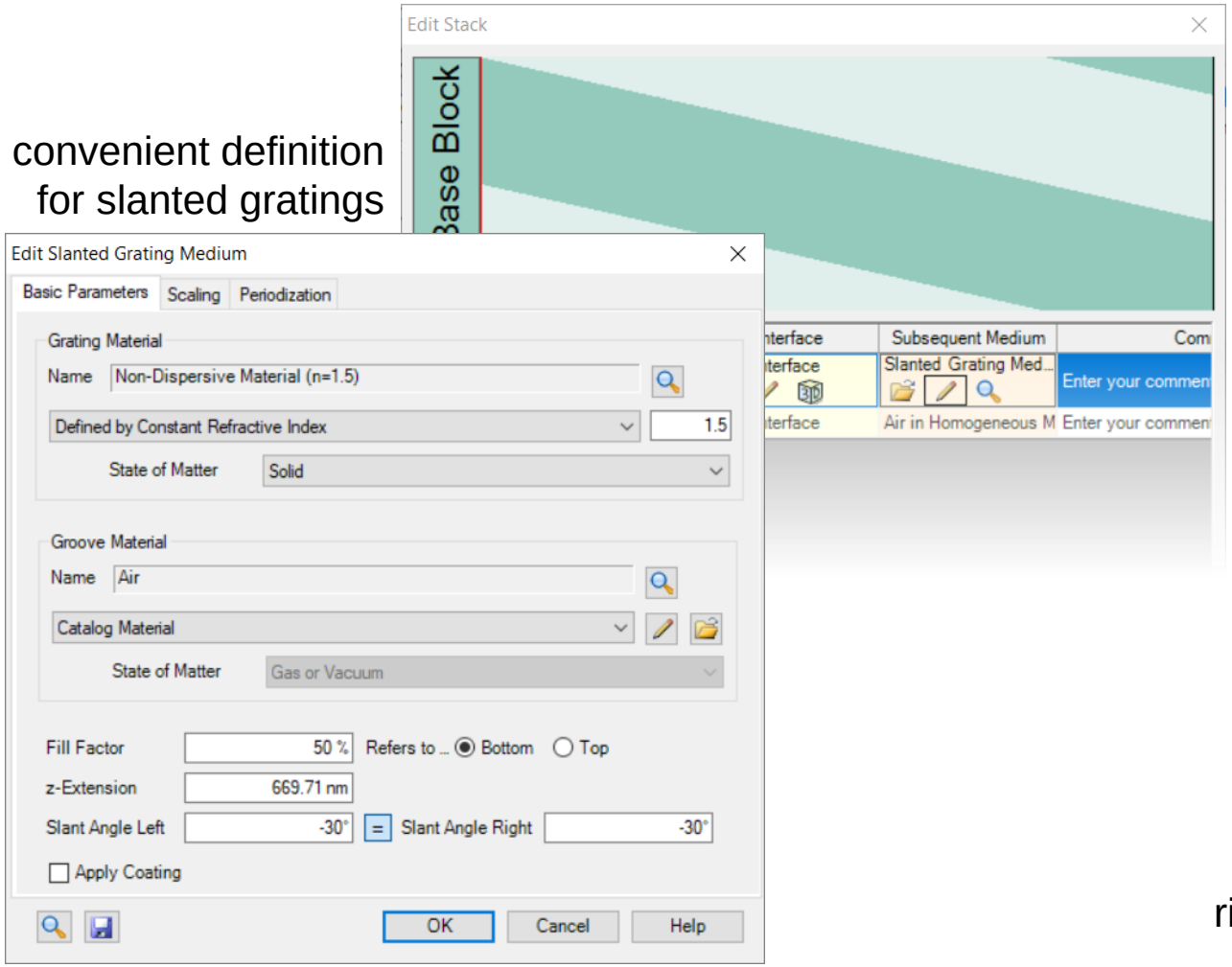
input plane wave
- wavelength: 633nm
- angle of incidence: **45±10°**
- TE polarized

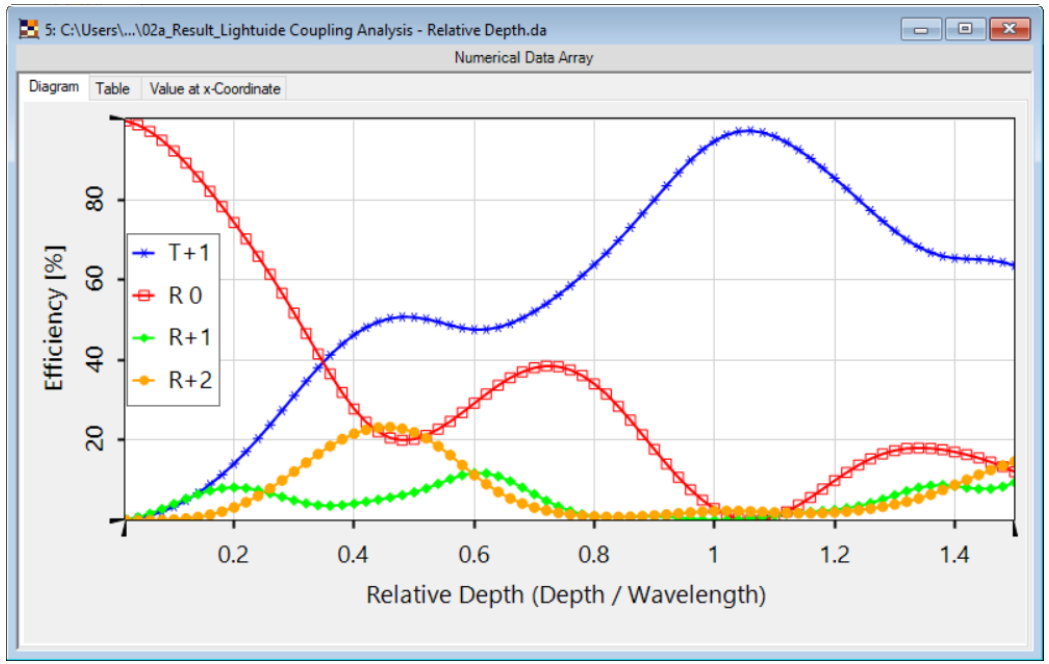
Grating diffraction efficiency is usually sensitive to the angle of incidence.



Peek into VirtualLab Fusion

convenient definition
for slanted gratings

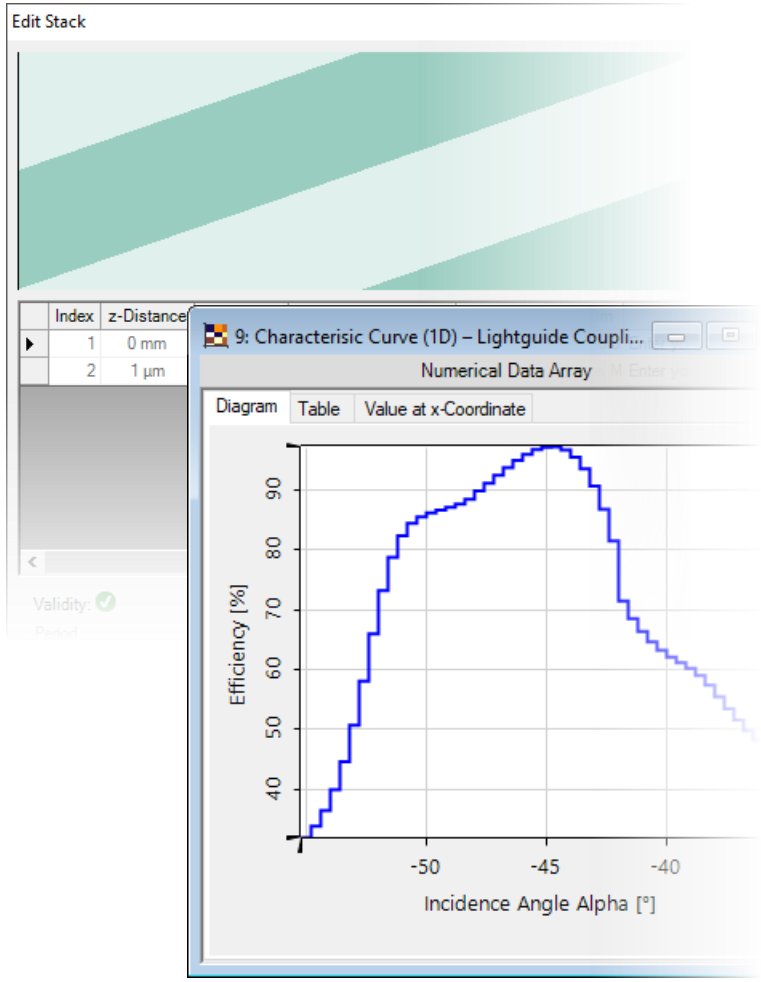




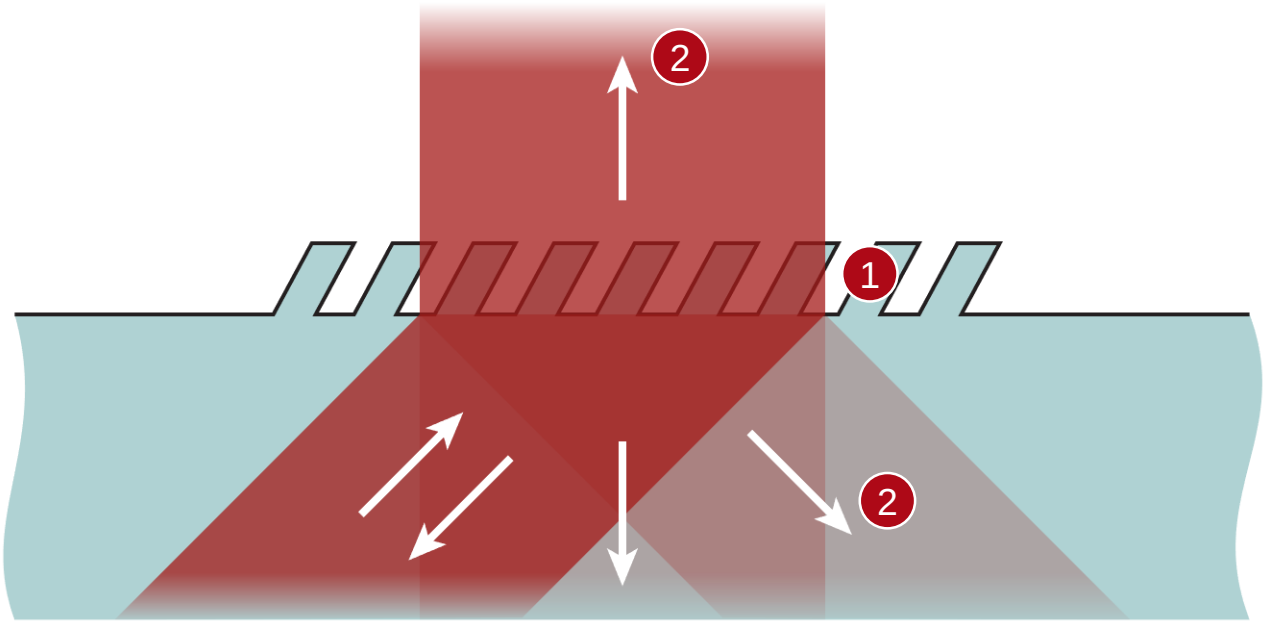
rigorous diffraction efficiency calculation and visualization

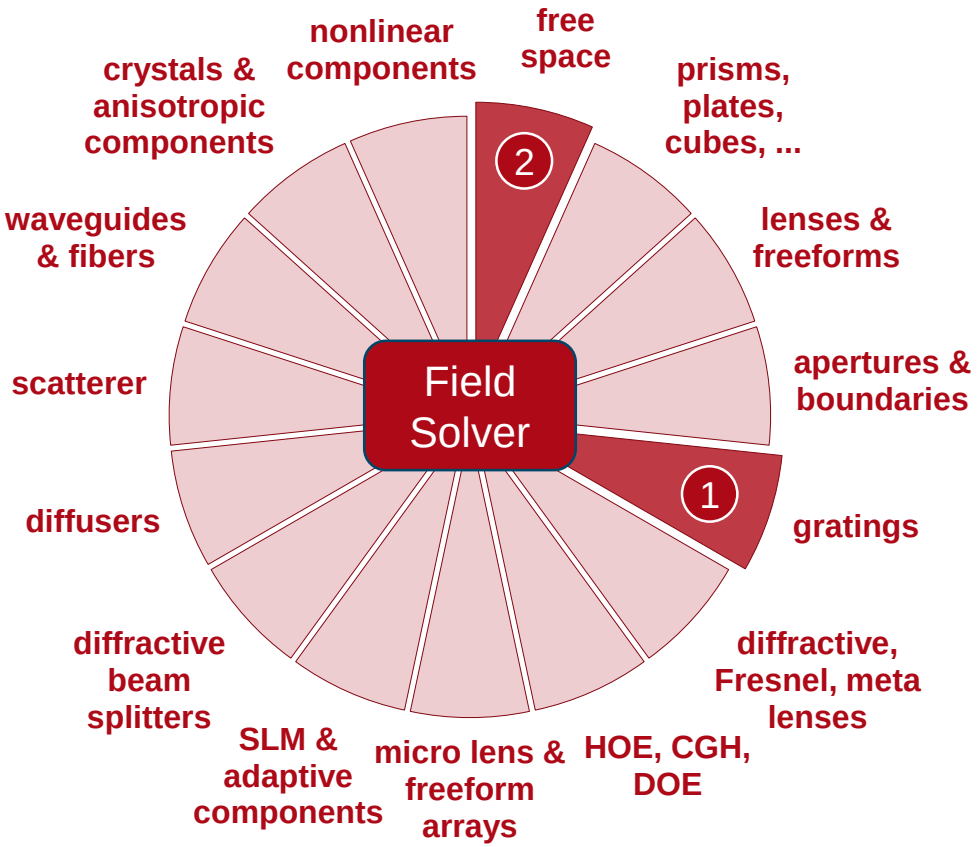
Workflow in VirtualLab Fusion

- 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
version	2.0
toolbox(es)	Grating Toolbox
VL version used for simulations	VirtualLab Fusion Summer Release 2019 (7.6.1.18)
category	Application Use Case
further reading	- Parametric Optimization and Tolerance Analysis of Slanted Gratings - Configuration of Grating Structures by Using Special Media