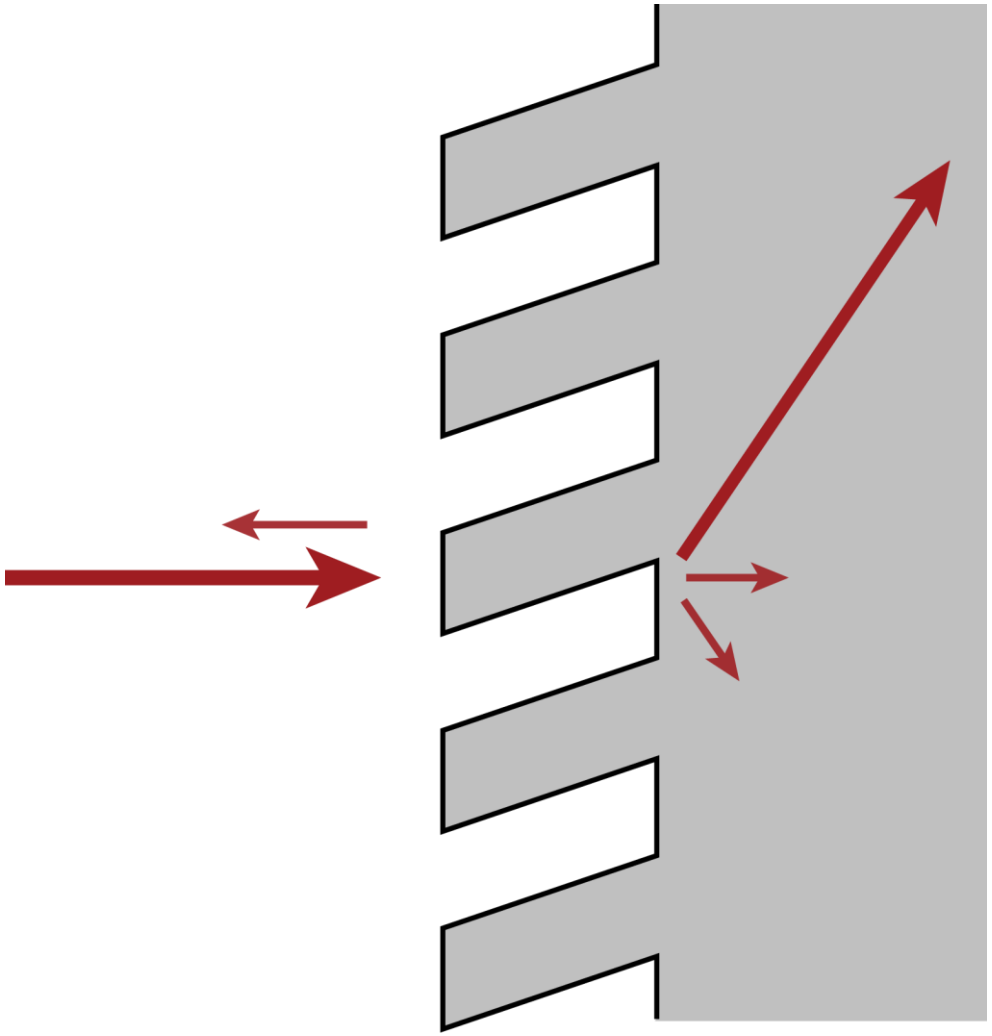
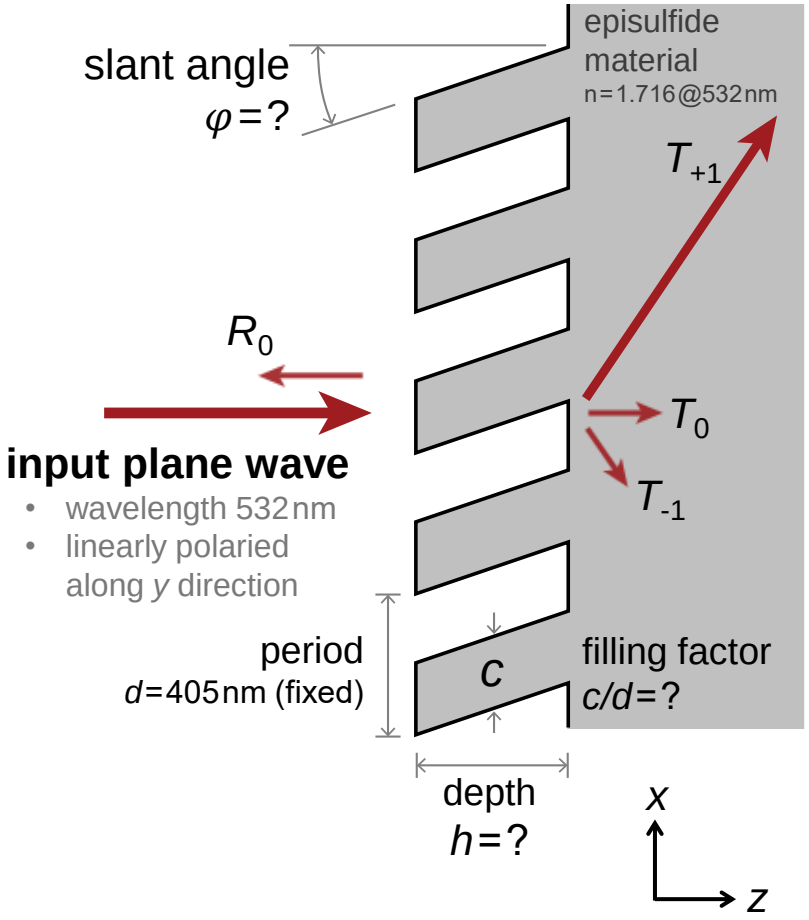
Parametric Optimization and Tolerance Analysis of Slanted Gratings

Abstract

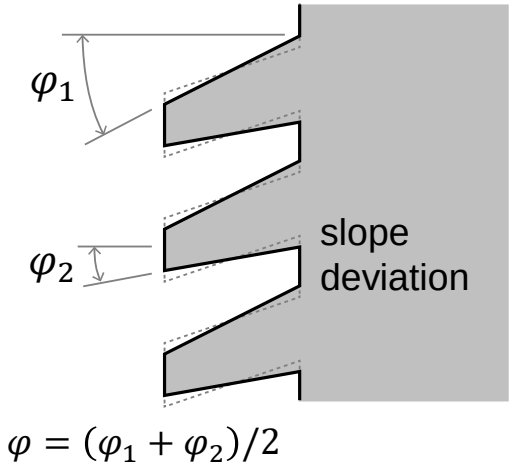


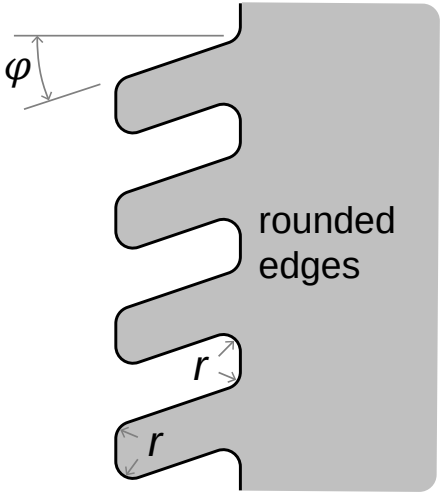
Coupling of light into guiding structures with high efficiency is an important issue for many applications, like backlight, optical interconnector, and near-to-eye displays. For such applications, slanted gratings are well-known for being capable to couple monochromatic light with high efficiency. In this example, the optimization of a slanted grating with the rigorous Fourier modal method (FMM, also known as RCWA) is presented. The optimized grating shows a diffraction efficiency of over 90% for a predefined direction order. In addition, the influence from the slope deviation and the rounded edges of the grating are investigated.

Modeling Task



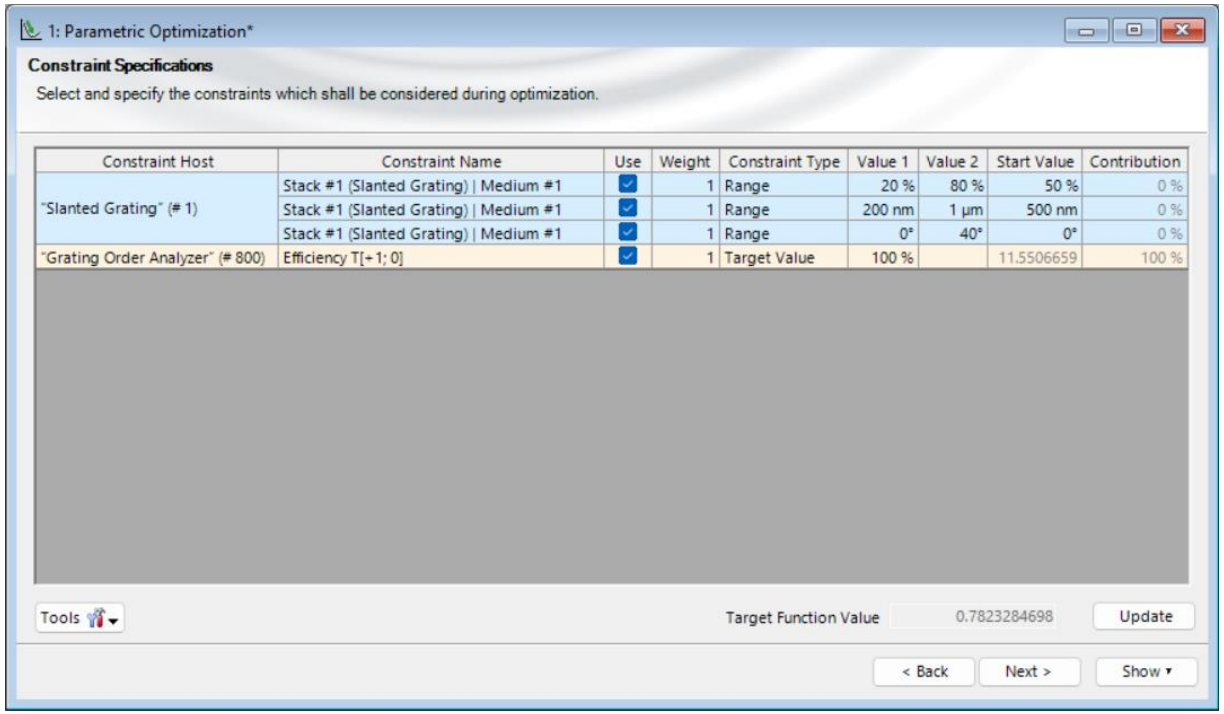
How to optimize the diffraction efficiency of the T_{+1} order, by adjusting the slant angle φ, grating depth h, and filling factor c/d?

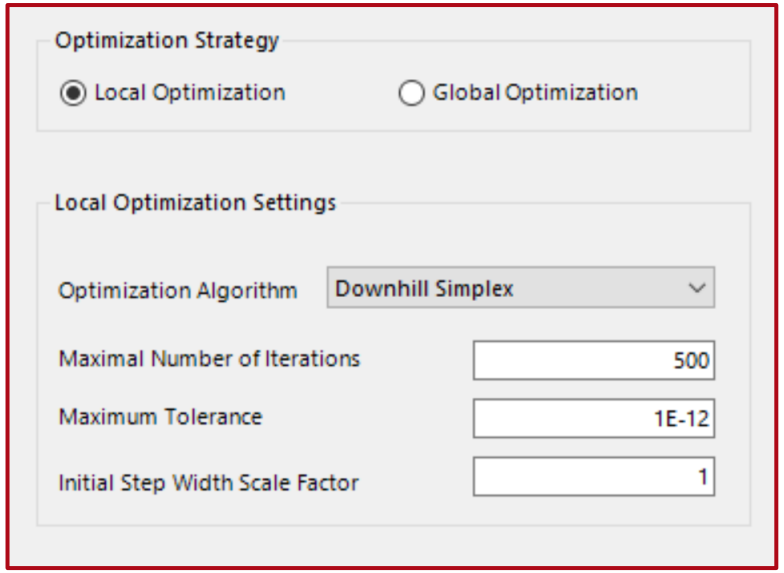




In addition, how to evaluate the grating performance with the slope deviation and the rounded edges due to fabrication processes taken into account?

Optimization



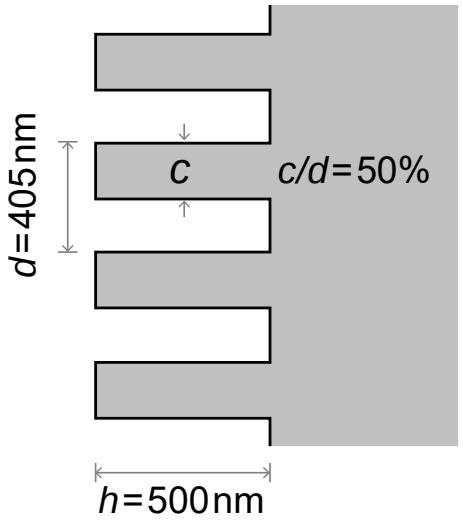


In order to find an optimized set of parameters for the slanted grating, the *Optimization* document enables the definition of parameter constraints and weights for the target values. Find more information under:

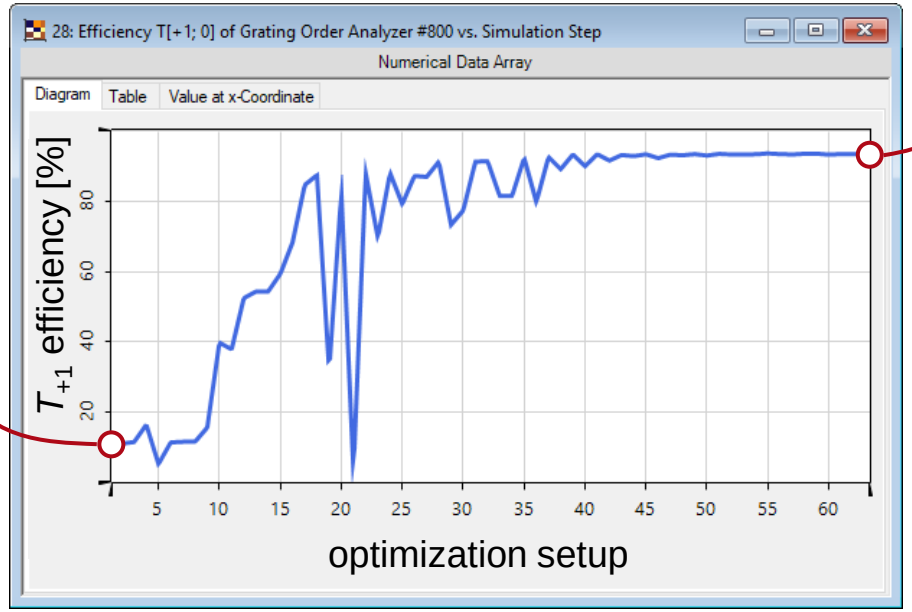
Introduction to the Parametric Optimization Document

Parametric Optimization for 1st Order

initial structure

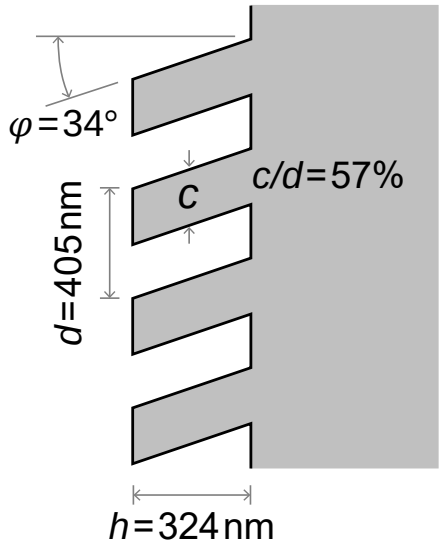


Order	Efficiency
-1	11.551%
0	72.795%
+1	11.551%



parametric optimization – downhill simplex method – with rigorous Fourier modal method (FMM) used for grating efficiency calculation

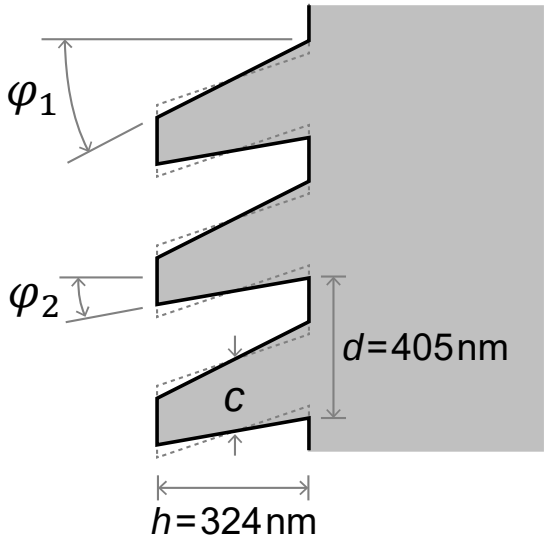
optimized structure



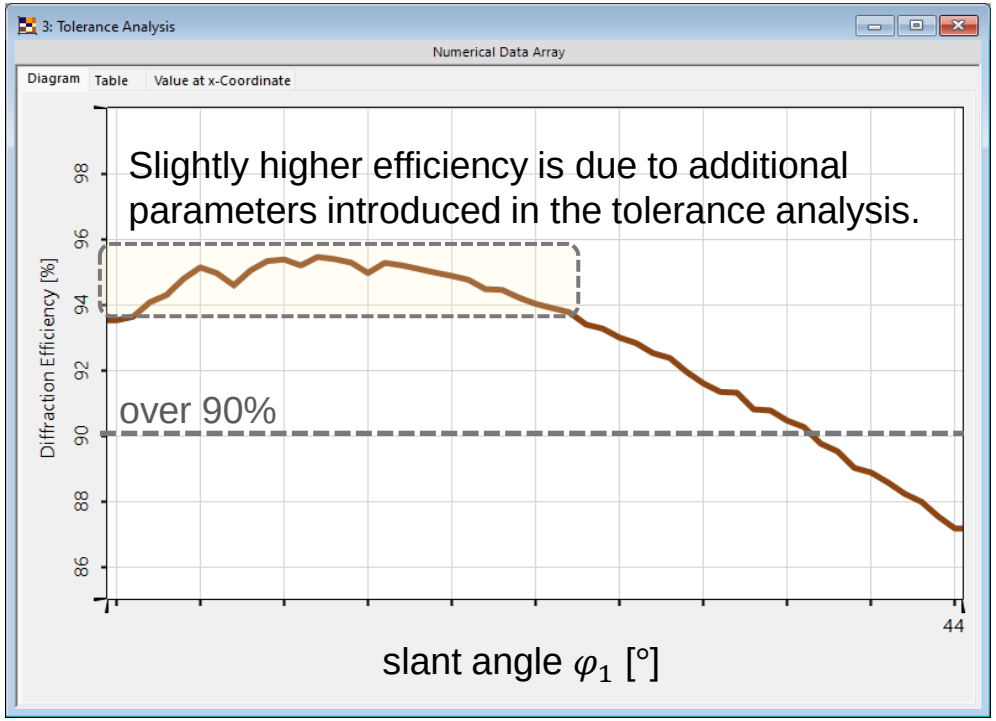
Order	Efficiency
-1	3.257%
0	0.365%
+1	**93.659%**

Results – Tolerance Analysis

The fabricated slanted gratings often shows a deviation from the perfect parallel grating lines. Such deviations of the angles of the sidewalls should be taken into account for the tolerance analysis.



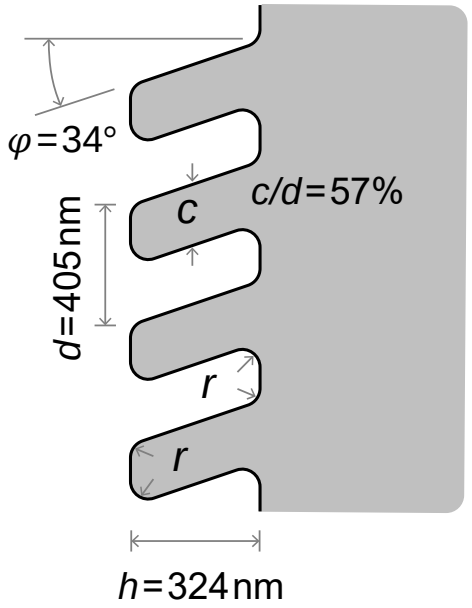
- fixed average slant angle $\varphi = (\varphi_1 + \varphi_2)/2 = 34°$
- fixed filling factor (average) c/d=57%
- varying φ_1 from 34 to 44°



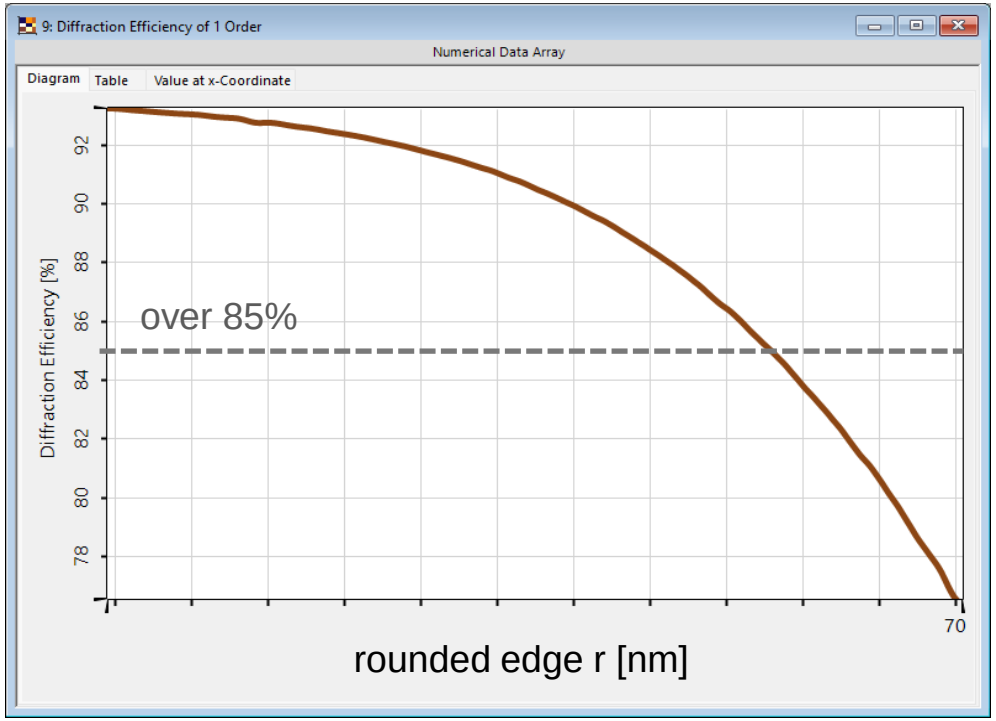
Rigorous simulation with Fourier modal method (FMM).

Results – Tolerance Analysis

The fabricated slanted gratings often shows a deviation from the perfect parallel grating lines. The rounded edges should be taken into account for the tolerance analysis.

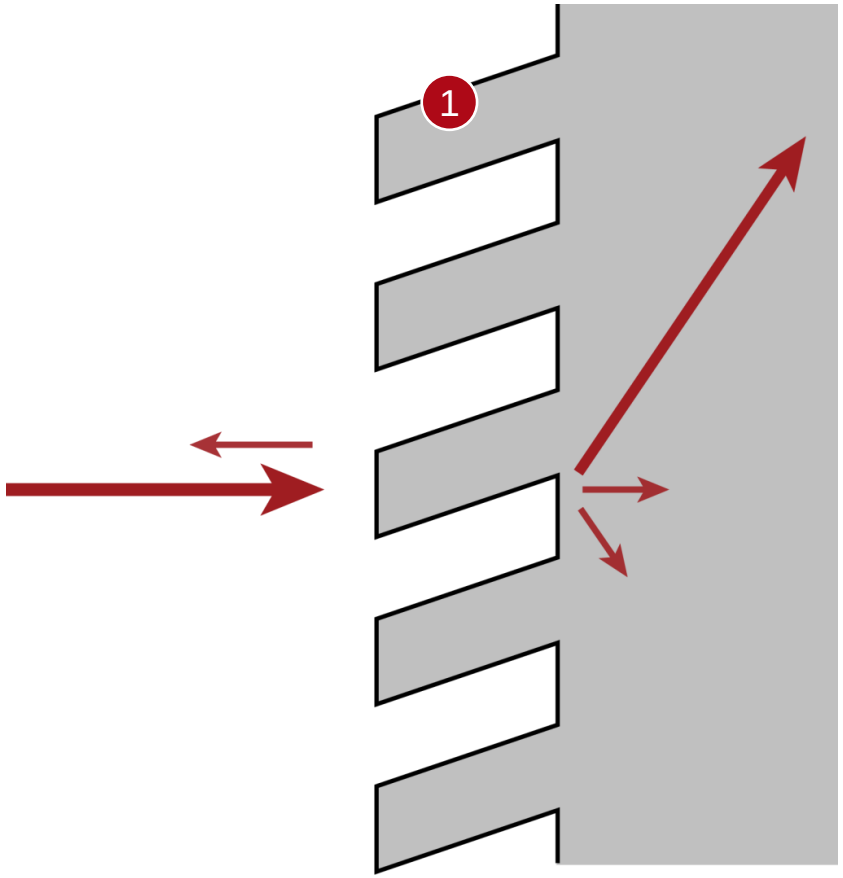


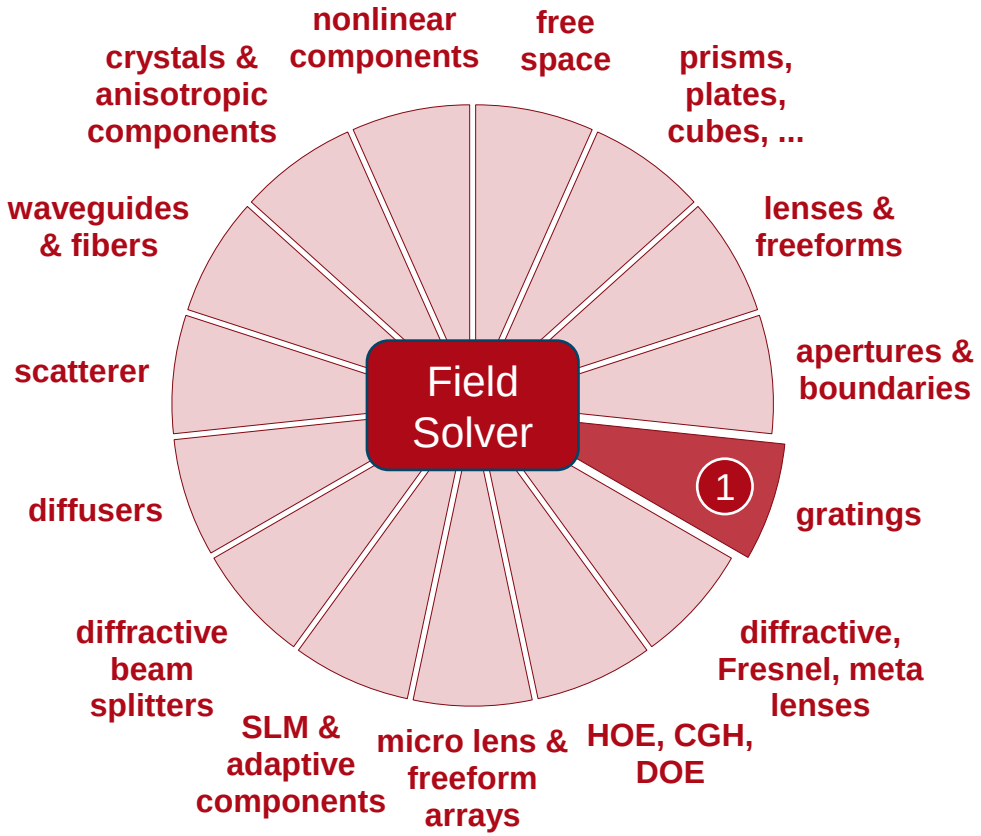
- fixed average slant angle $\varphi = 34°$
- fixed filling factor c/d=57%
- varying *r* from 15 nm 70 nm



Rigorous simulation with Fourier modal method (FMM).

VirtualLab Fusion Technologies





Document Information

title	Parametric Optimization and Tolerance Analysis of Slanted Gratings
document code	GRT.0007
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further reading	• Analysis of Slanted Gratings for Lightguide Coupling • Optimization of Lightguide Coupling Grating for Single Incidence Direction • Introduction to the Parametric Optimization Document • Advanced Configuration of Slanted Gratings • Configuration of Grating Structures by Using Interfaces • Grating Order Analyzer