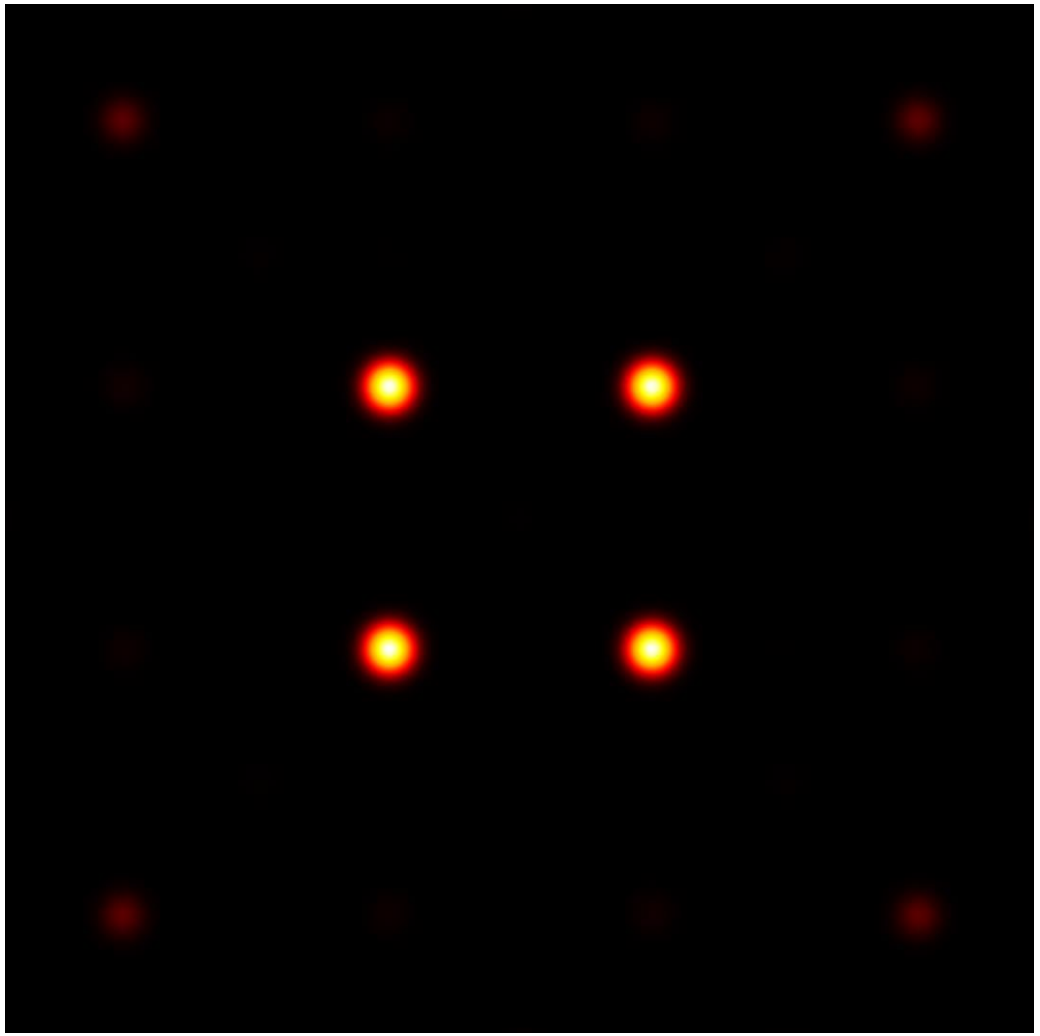
Angular-Filtering Volume Grating for Suppressing Higher Diffraction Orders

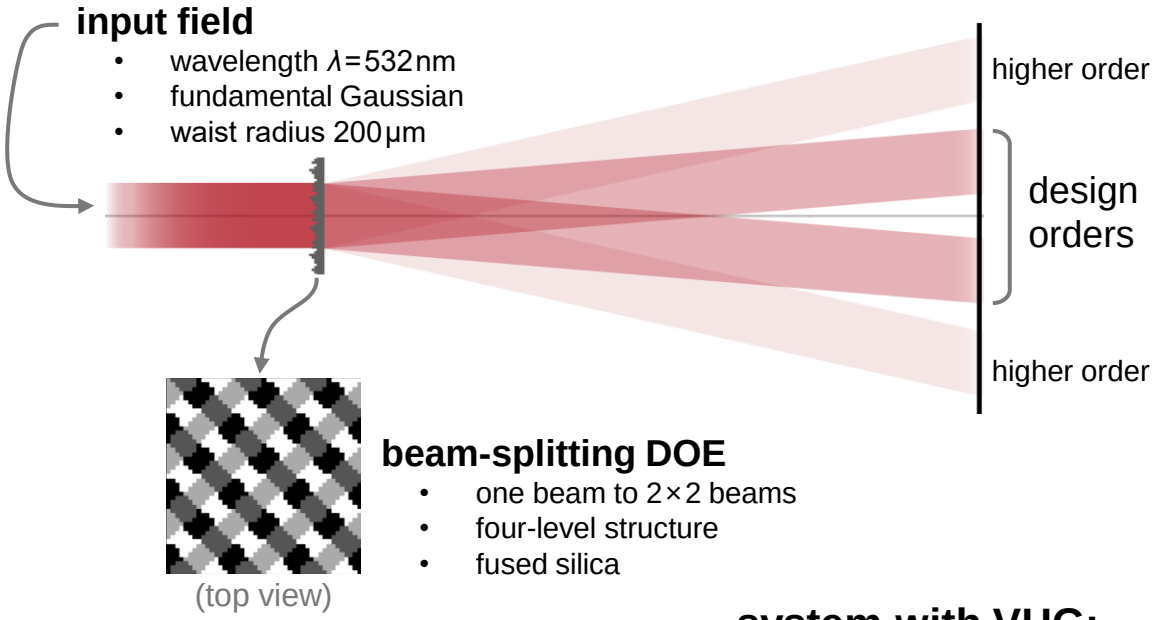
Abstract



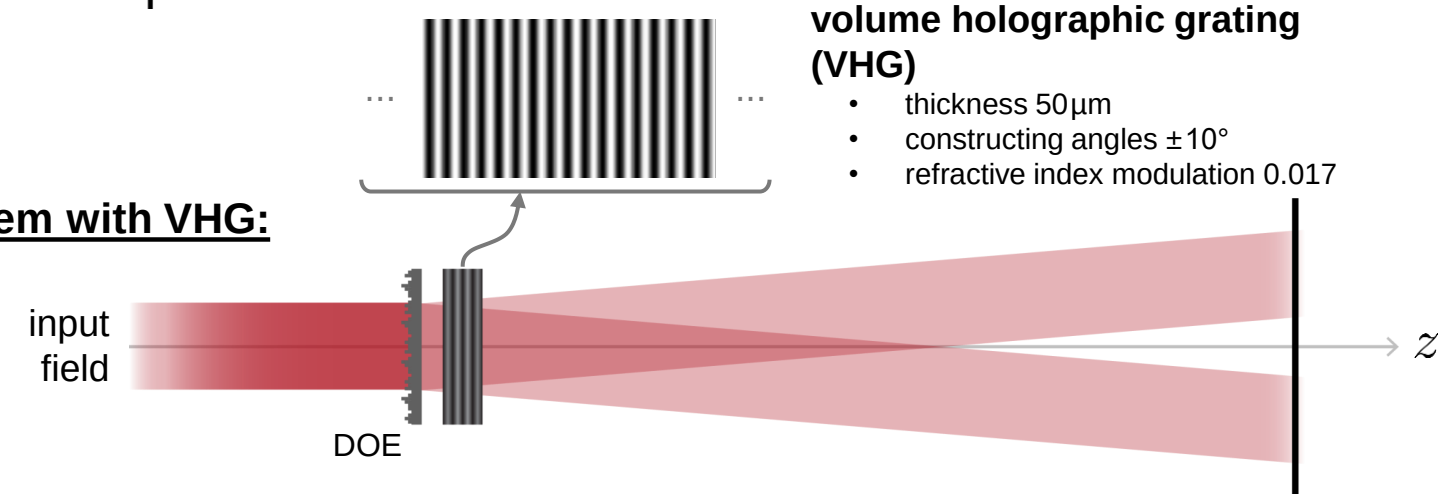
Holographic volume gratings, which are usually made by two-beam interference, are known for their wavelength and angle sensitivities. Because of that, they can be designed to work as angular stop filters. In this example, following the work of Bang *et al*., a volume grating is constructed as angular filter in a beam-splitting DOE system in order to suppress undesired higher diffraction orders. For this purpose, the angular sensitivities of the volume grating is analyzed first. Finally, the suppression of the undesired higher diffraction orders are shown in the simulation by using VirtualLab Fusion.

Modeling Task

reference system:

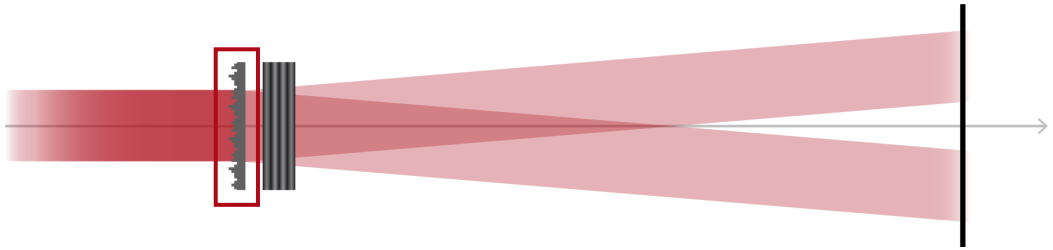


system with VHG:

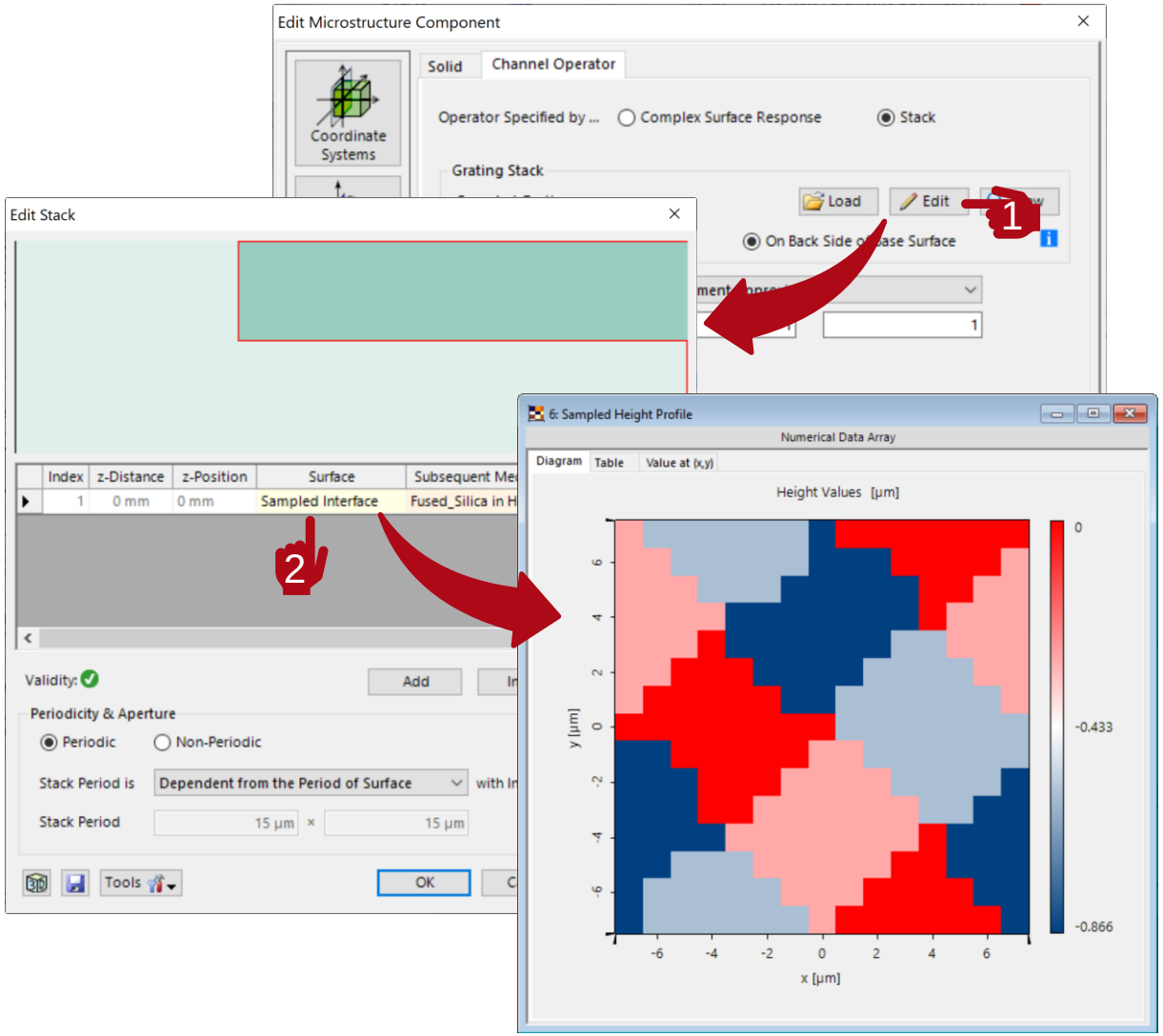


volume grating parameters from K. Bang, *et al*., Opt. Lett. 44, 2133-2136 (2019)

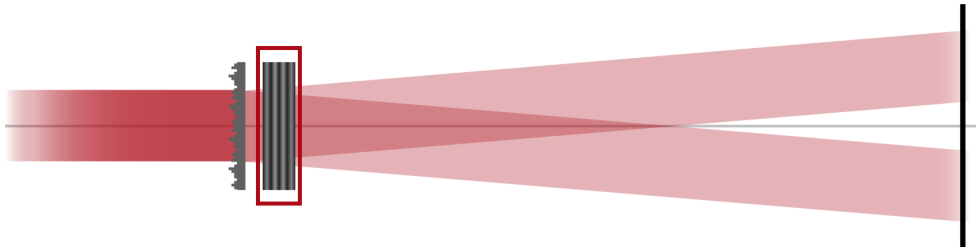
Diffractive Optical Element (DOE)



The *Microstructure Component* allows for a modeling of diffractive structures by advanced TEA (thin element approximation). In our example the beam splitting DOE is given as a *Sampled Interface*. This interface can be converted into a *Stack* and then loaded into the *Microstructure Component*.



Volume Holographic Grating (VHG)

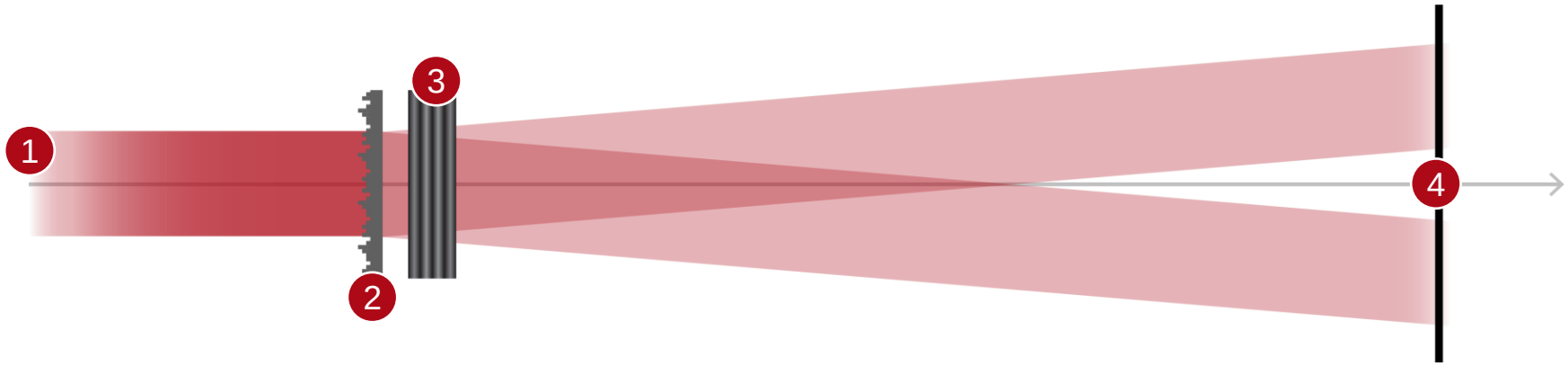


The grating components offer a specialized *Volume Grating Media* to model the VHG:

- Use the *General Grating Component* in the *General Grating Optical Setup* to investigate the properties of the VHG, such as the angle-dependence.
- Import the medium then to the *Grating Component* of the regular *Optical Setup* to simulate the entire system including the DOE.

More information under:
[Holographically Generated Volume Grating]

Summary – Components...

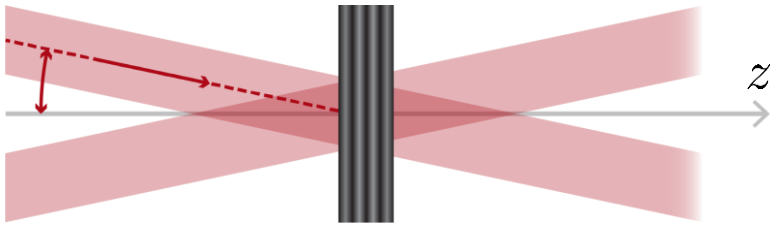


… of Optical System	… in VirtualLab Fusion	Model/Solver/Detected Value
1. source	*Gaussian Wave*	spatial gaussian function
2. DOE	*Microstructure Component*	Thin-Element Approximation (TEA)
3. volume grating	*Grating Component* with *Volume Grating Medium*	Fourier Modal Method (FMM)
4. detector	*Camera Detector*	energy density measurement

Analysis of Angular Transmittance

input field

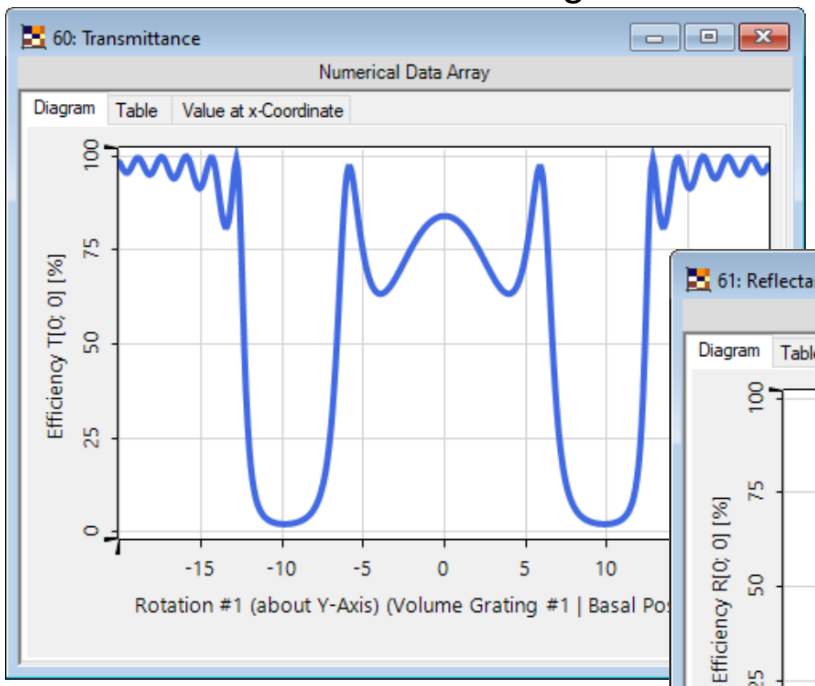
- wavelength $\lambda = 532\,\text{nm}$
- plane wave
- incidence angle from -20 to +20°



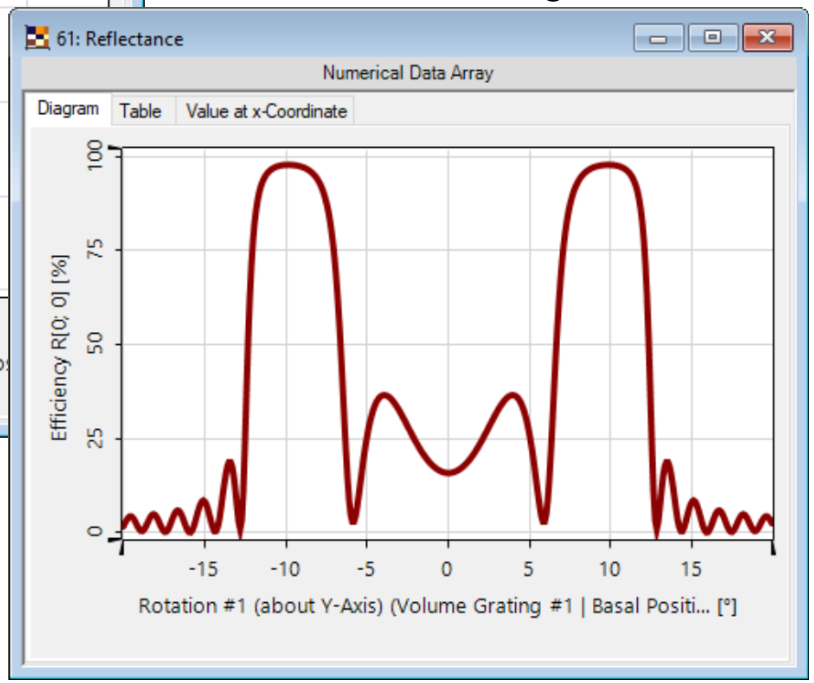
volume grating

- thickness 50 µm
- constructing angle ±10°
- refractive index modulation 0.017

transmittance vs angle

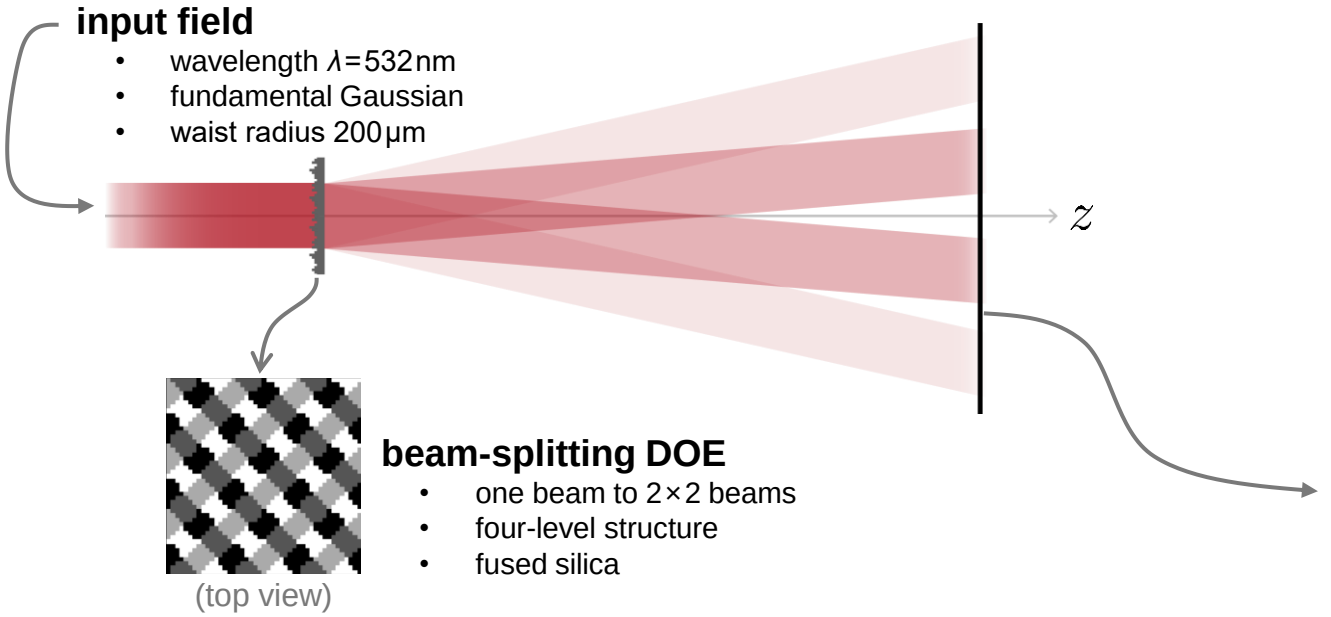


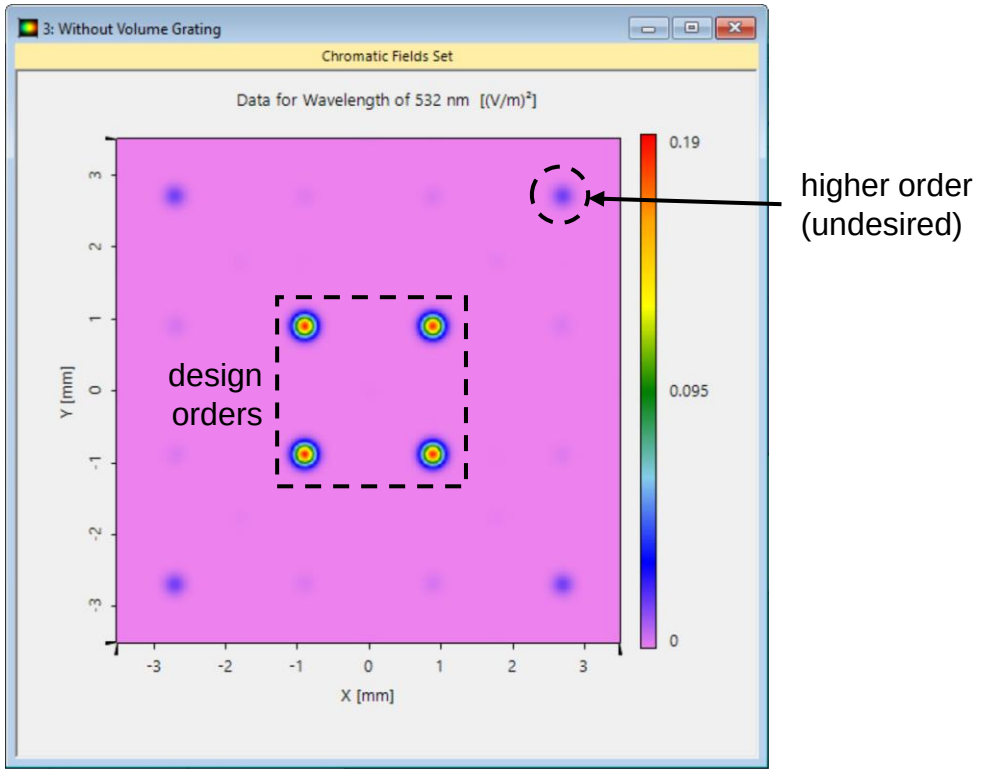
reflectance vs angle



The FMM / RCWA is used to calculate the transmittance and reflectance of the holographic volume grating.

Analysis of Original Beam-Splitting System (without VHG)



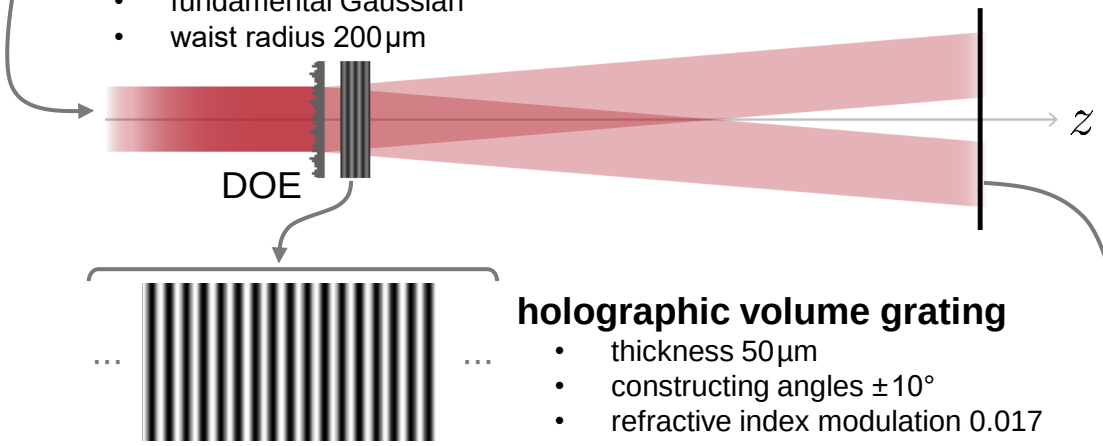


higher order (undesired)

Analysis of Beam-Splitting System with VHG

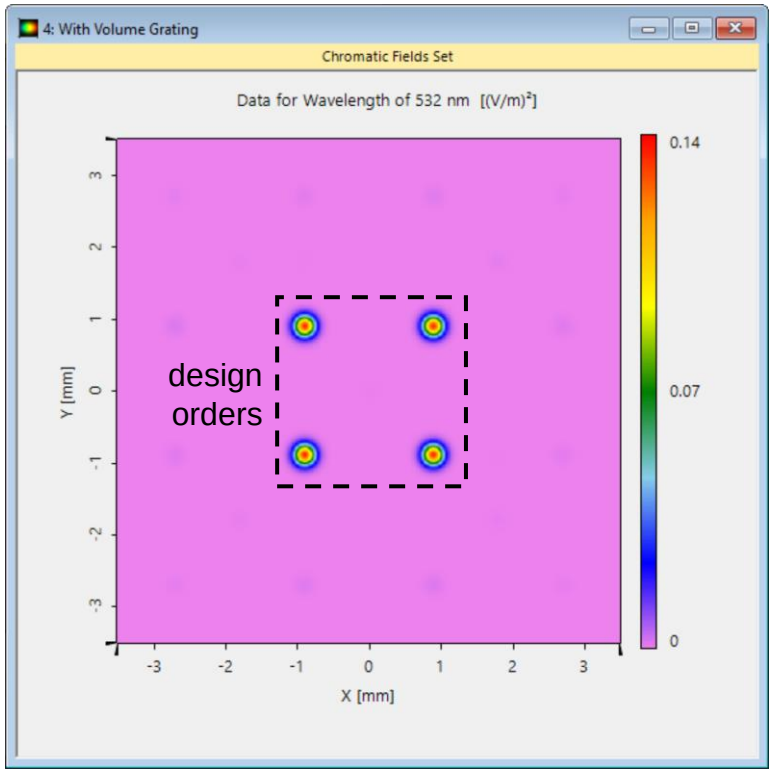
input field

- wavelength $\lambda = 532\,\text{nm}$
- fundamental Gaussian
- waist radius $200\,\mu\text{m}$



holographic volume grating

- thickness $50\,\mu\text{m}$
- constructing angles $\pm 10°$
- refractive index modulation 0.017

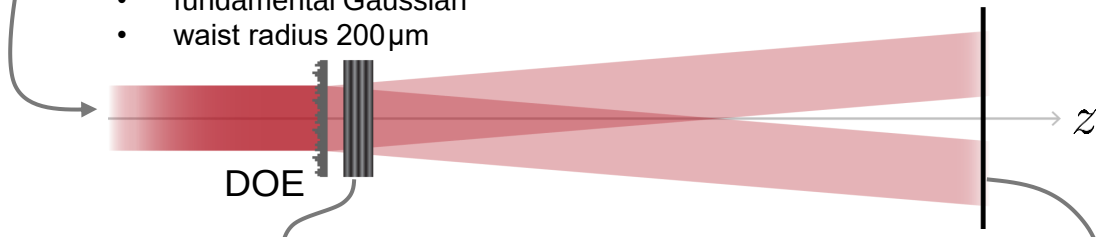


higher orders effectively suppressed

Angular Filtering Effect of Volume Grating

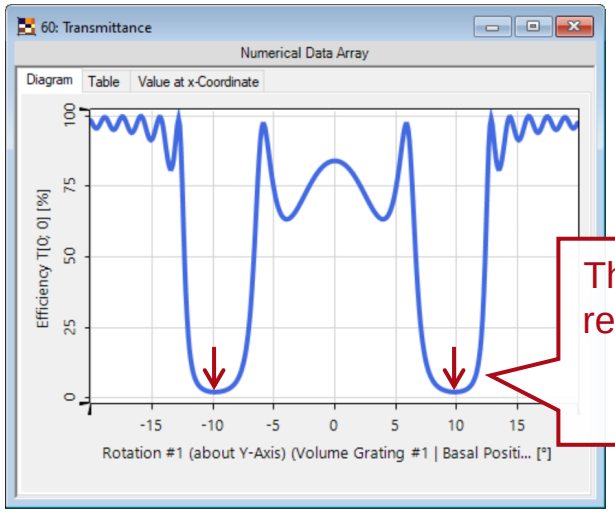
input field

- wavelength $\lambda = 532\,\text{nm}$
- fundamental Gaussian
- waist radius 200 µm



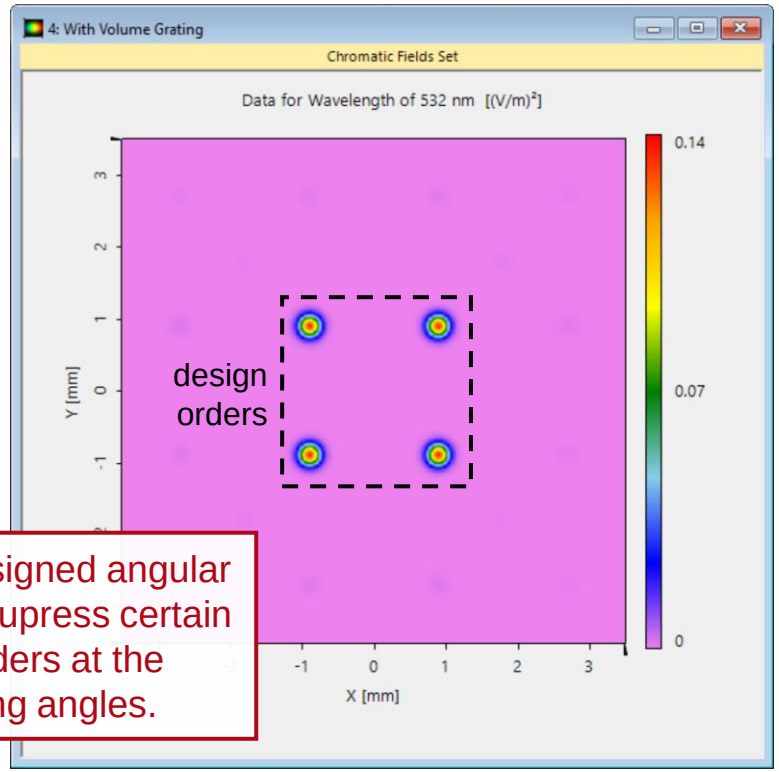
holographic volume grating

- thickness 50 µm
- constructing angles ±10°



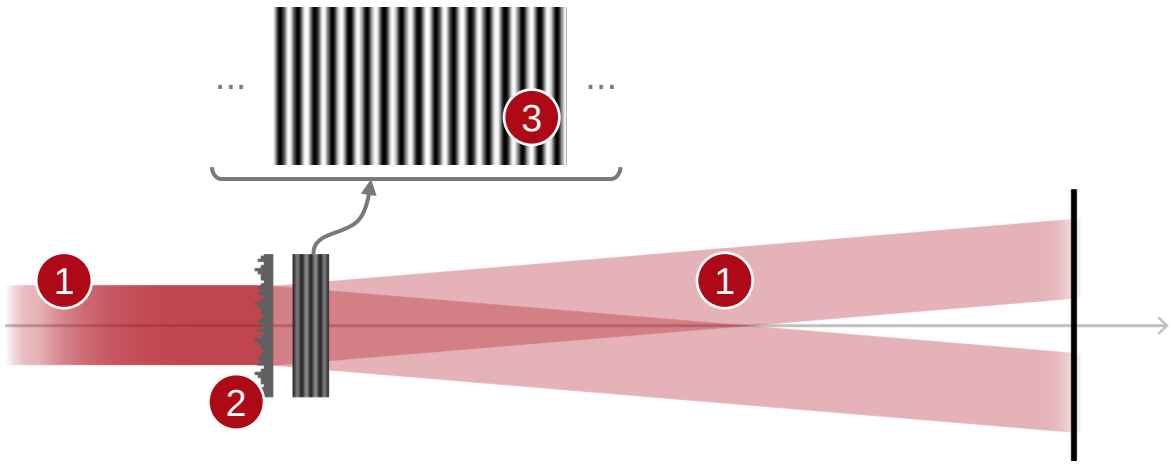
transmittance vs incidence angle

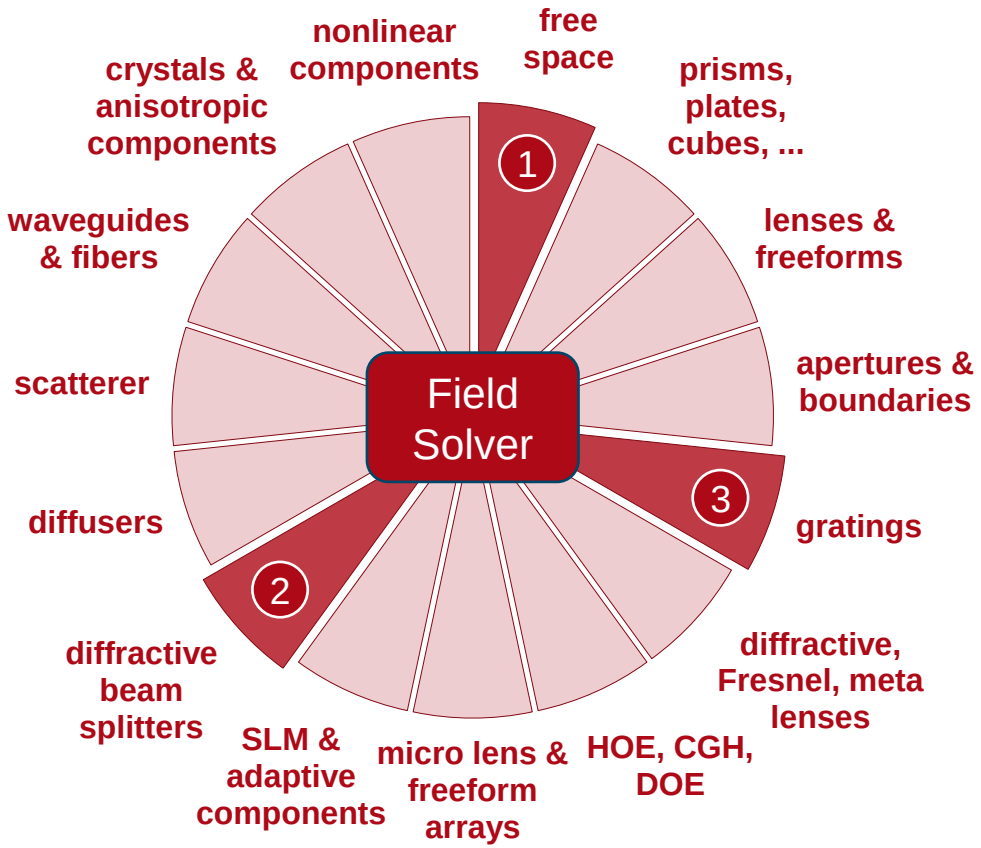
The specially designed angular response helps supress certain diffraction orders at the corresponding angles.



higher orders effectively supressed

VirtualLab Fusion Technologies





Document Information

title	Angular-Filtering Volume Gratings for Suppressing Higher Diffraction Orders
document code	GRT.0025
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software version	2021.1 (Build 1.180)
category	Application Use Case
further reading	- Holographically Generated Volume Grating - Modeling of Gratings within Optical System - Discussion at Examples