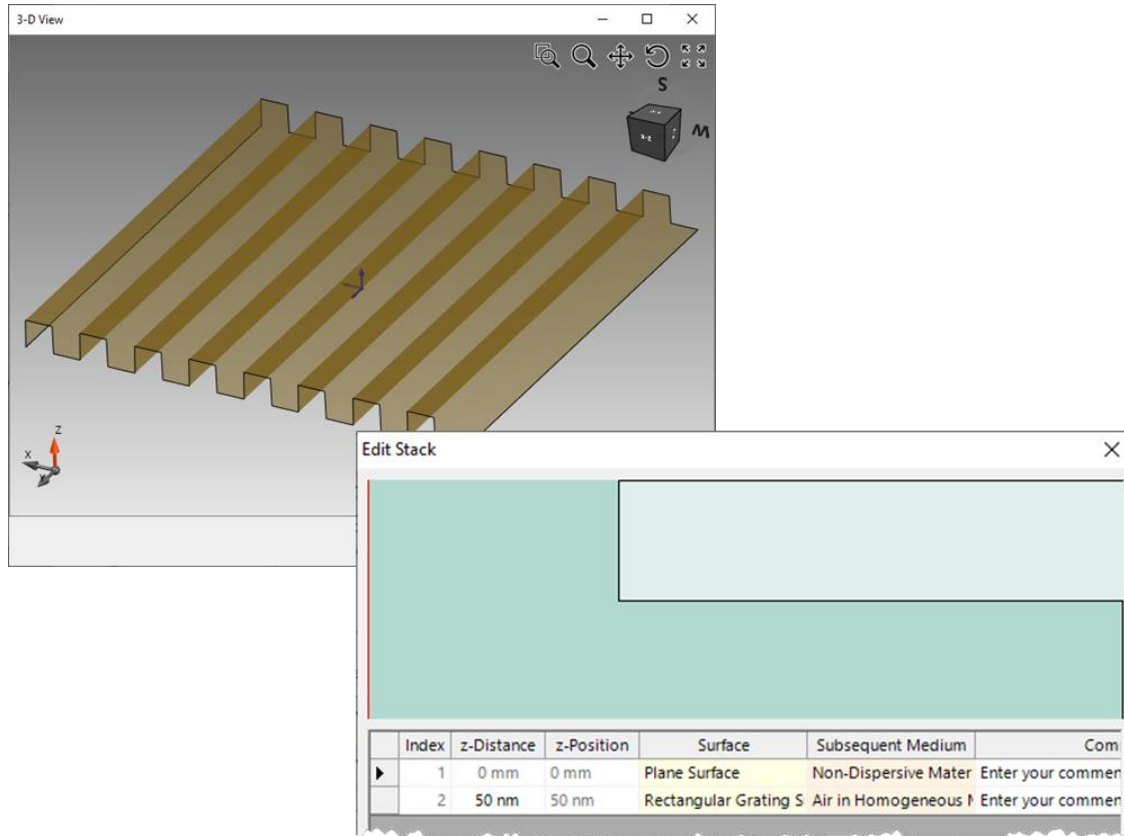


Grating Component for General Optical Systems

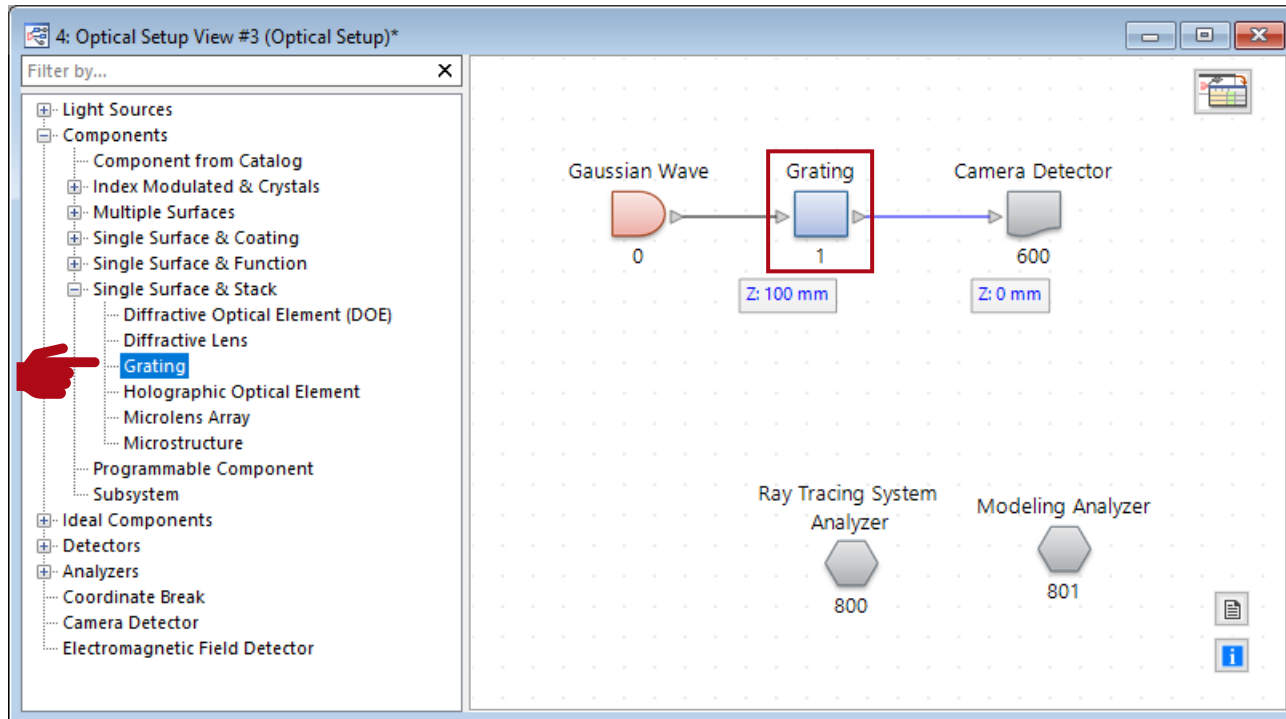
Abstract



Gratings are one of the most commonly used diffractive elements in optics. Nowadays, they are often employed in complex systems and work together with other components. In such cases, there is a strong need to simulate gratings, not just as isolated elements, but in conjunction with the rest of the system, to evaluate overall system performance.

VirtualLab Fusion offers a distinct Grating Component that allows for an easy inclusion of a wide variety of differently shaped gratings into an optical setup, whether they be 1D periodic (lamellar), 2D periodic, or volume (Bragg) gratings. This use case introduces the features of this component, including the setting of grating orders and positioning of the stack.

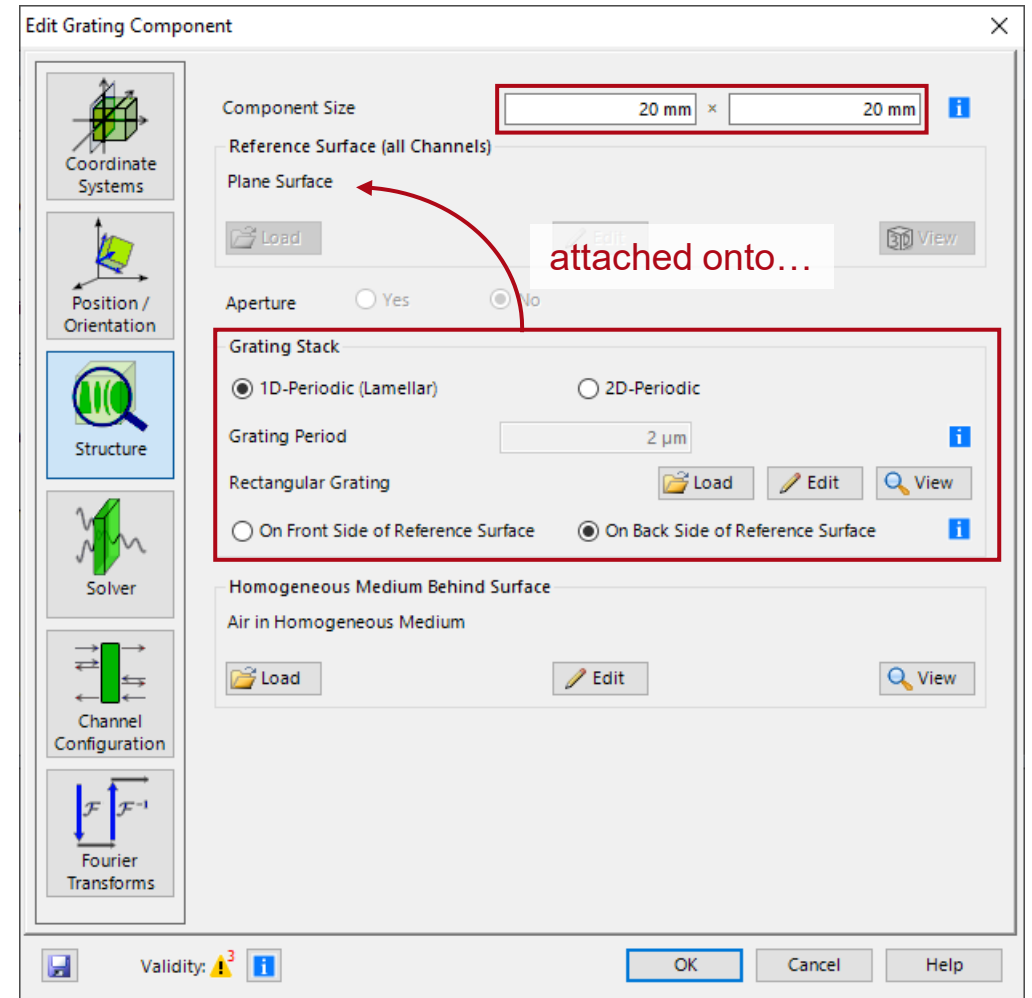
Grating Modeling within System



- In a general *Optical Setup*, a *Grating* component can be inserted in the system in any position.
- This enables the modeling of gratings within a complex system, and therefore to evaluate overall system performance, with the possible effects of the grating considered.
- The *Grating* component can be found via *Components > Single Surface & Stack > Grating*.

Attaching Grating Stack

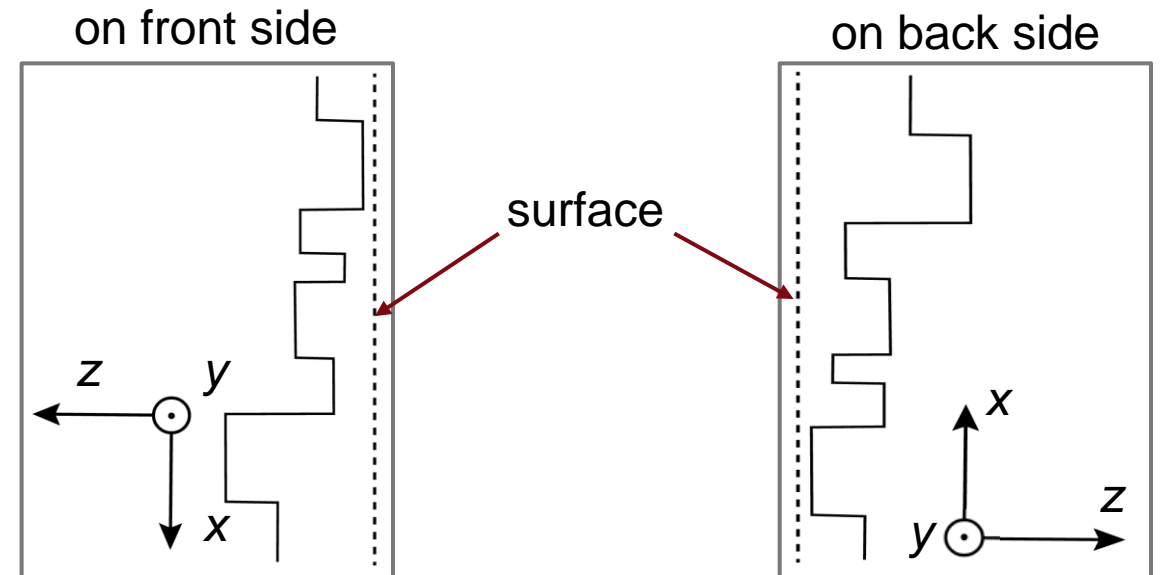
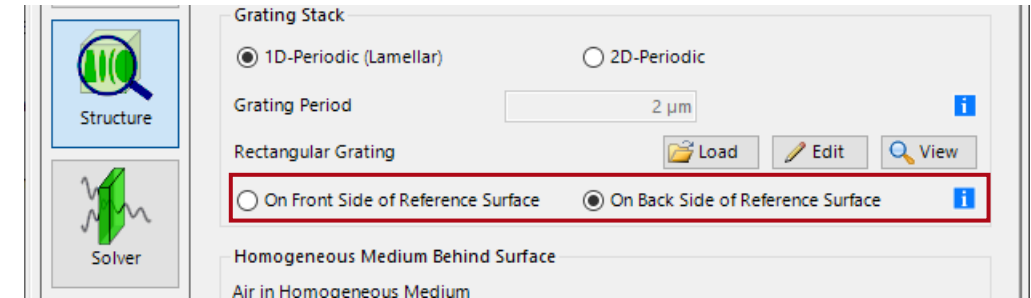
- To describe the grating within a system, a *Grating Stack* is always attached to a virtual reference surface (planar only).
- The size of the component is just for display purposes in the 3D ray tracing view; there is no aperture effect included in the simulation.
- The *Reference Surface* can be visualized in the 3D system view to help align the grating.
- The applied grating structure can be either 1D-periodic (lamellar) or even 2D-periodic (crossed grating).



Orientation of the Stack

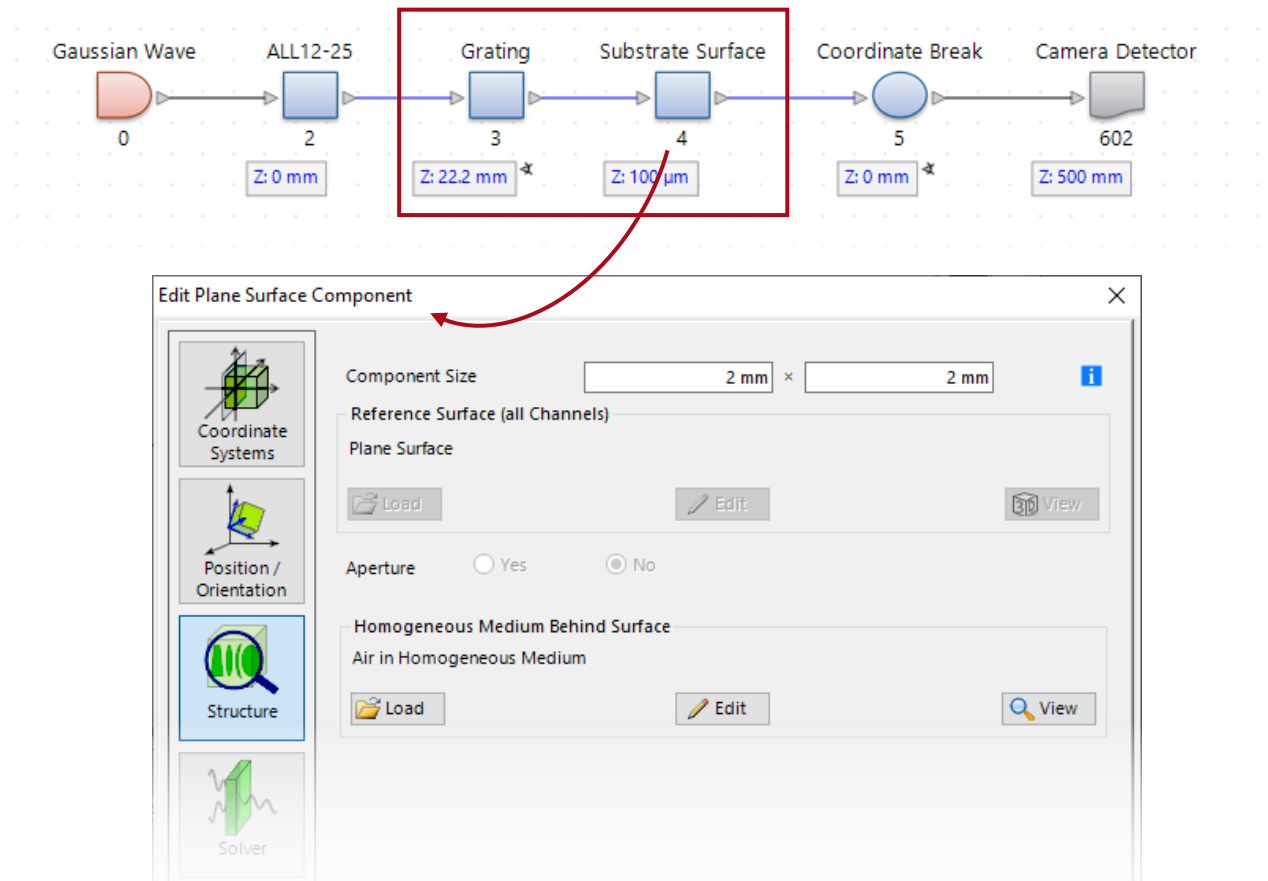
The orientation of the *Stack* can be specified in two ways:
It can either be applied on the front side of the surface or on its back side (defined in the *Solid* tab).

Please note that the stack will be rotated by 180 degrees around the Z axis if positioned on the front side. This influences the internal coordinate system of the *Stack* and needs to be considered during the definition of the height profile.



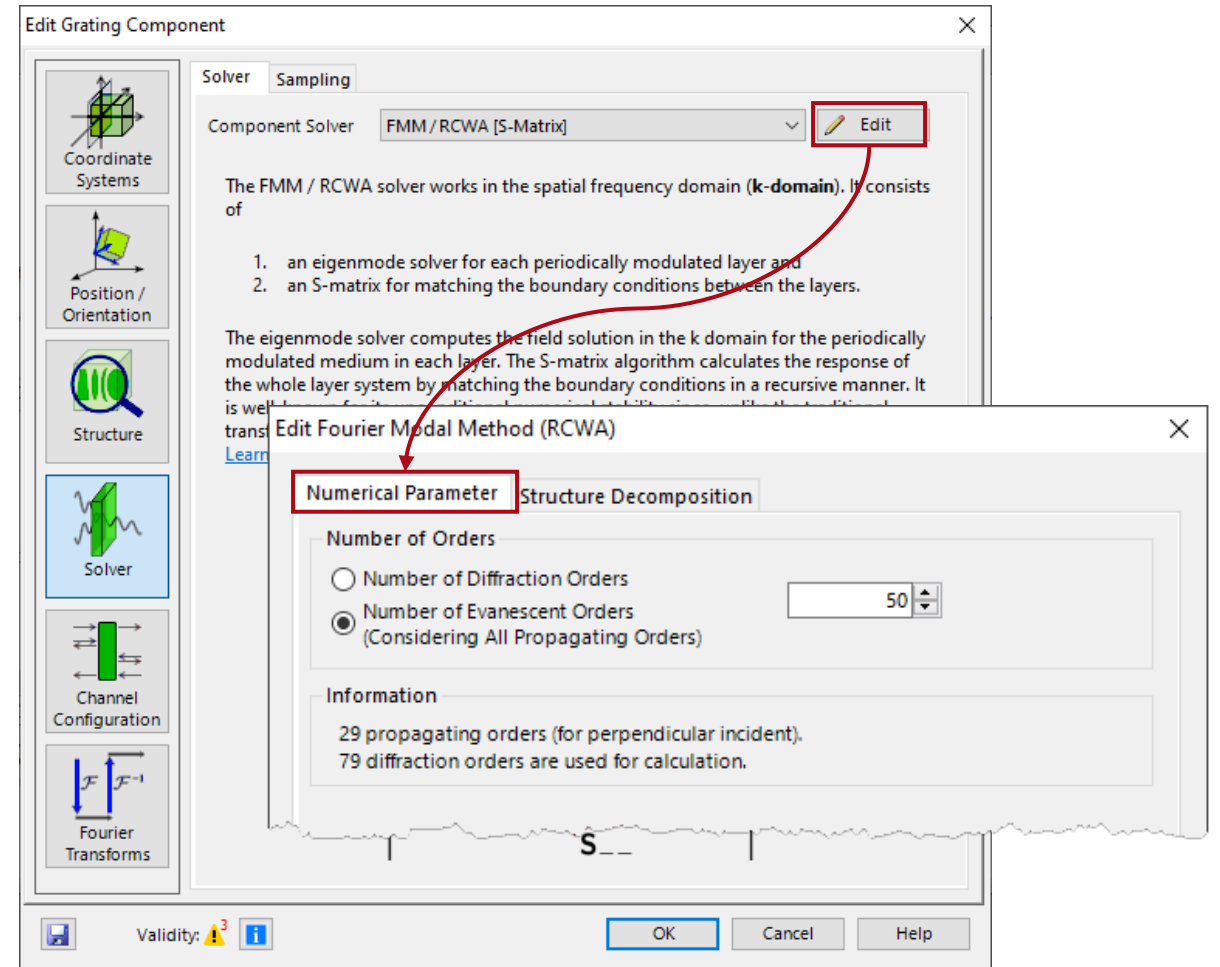
Handling of Substrate, Fresnel Loss, and Diffraction Angle

- As a convention, the effect of the substrate is often omitted for e.g., the diffraction efficiency calculation.
- However, any realistic grating structure must rest on a substrate, and as such we use a *Plane Surface* component together with a free-space stretch in between to model it.
- The modeling of the *Plane Surface* includes the Fresnel effect (S-matrix solver).



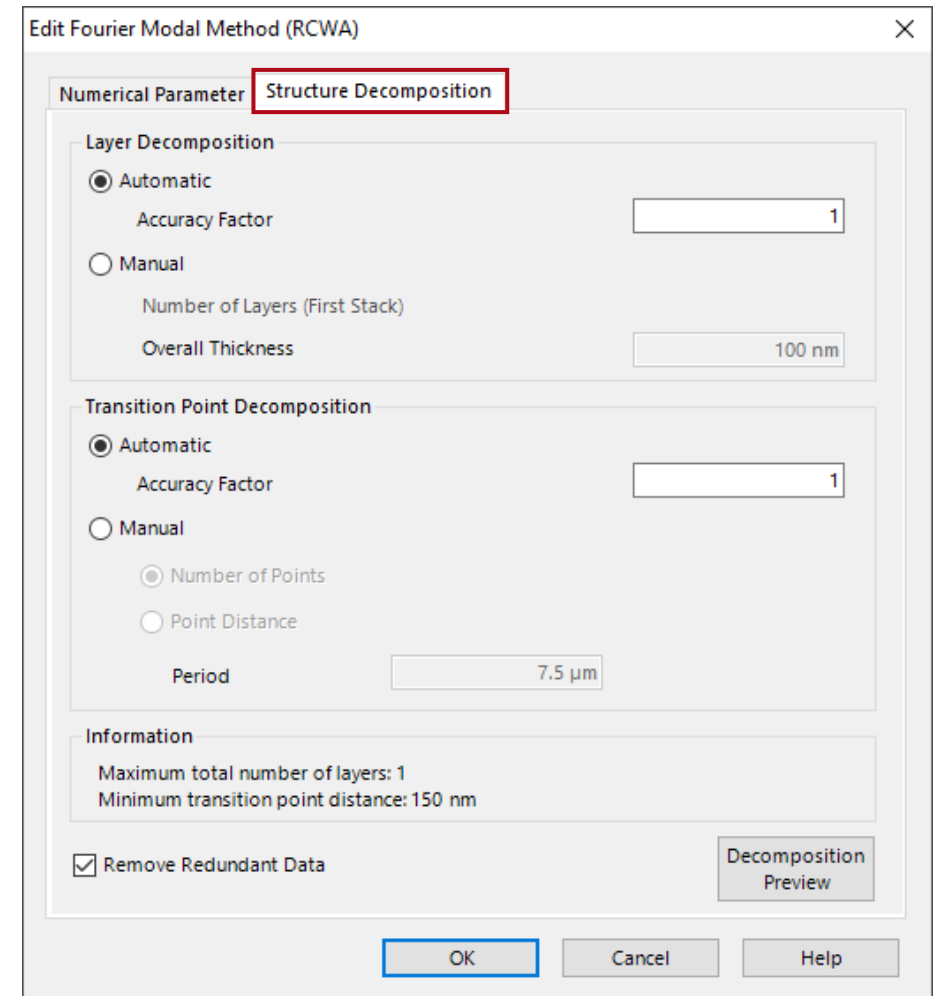
Advanced Options & Information

- In the *Solver* menu several advanced options are available.
- The *Solver* tab allows to edit the accuracy settings of the used FMM (“Fourier Modal method”, also known as RCWA, “rigorous coupled wave analysis”) algorithm.
- Either the numbers of considered total orders or evanescent orders can be set.
- This might be useful, if metallic gratings are considered. In contrast, in case of dielectric gratings, the default setting will be sufficient.



Structure Decomposition

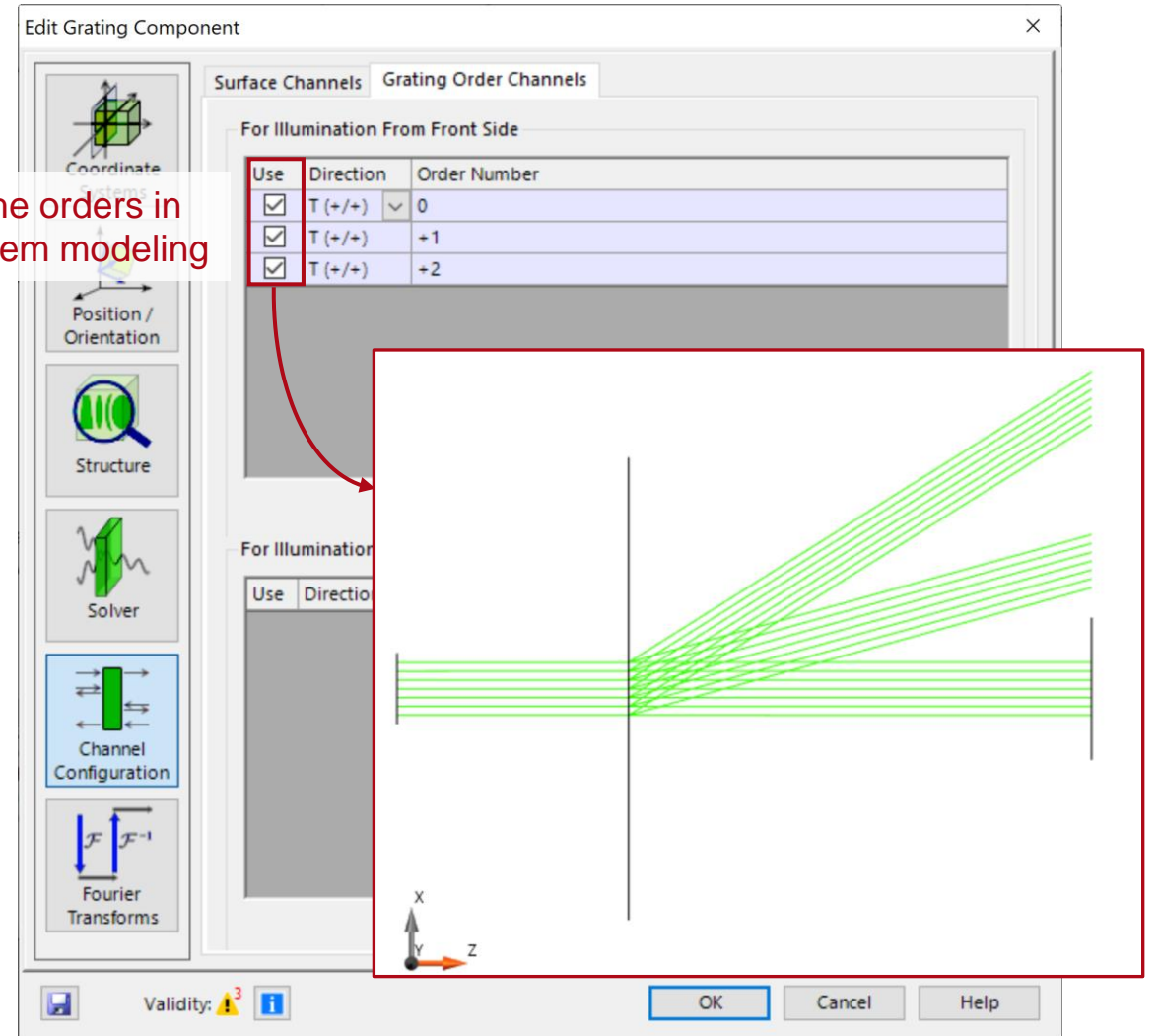
- The *Structure Decomposition* tab provides information about the decomposition of the structure.
- The *Layer Decomposition* and *Transition Point Decomposition* settings can be used to adjust the discretization of the structure. The default settings are appropriate for nearly all grating structures.
- Further, information about the number of layers and transition points are provided.
- The *Decomposition Preview* button provides a depiction of the structure data which are used for the FMM calculation. The refractive index is illustrated by a color scale.



Grating Order Channel Selection

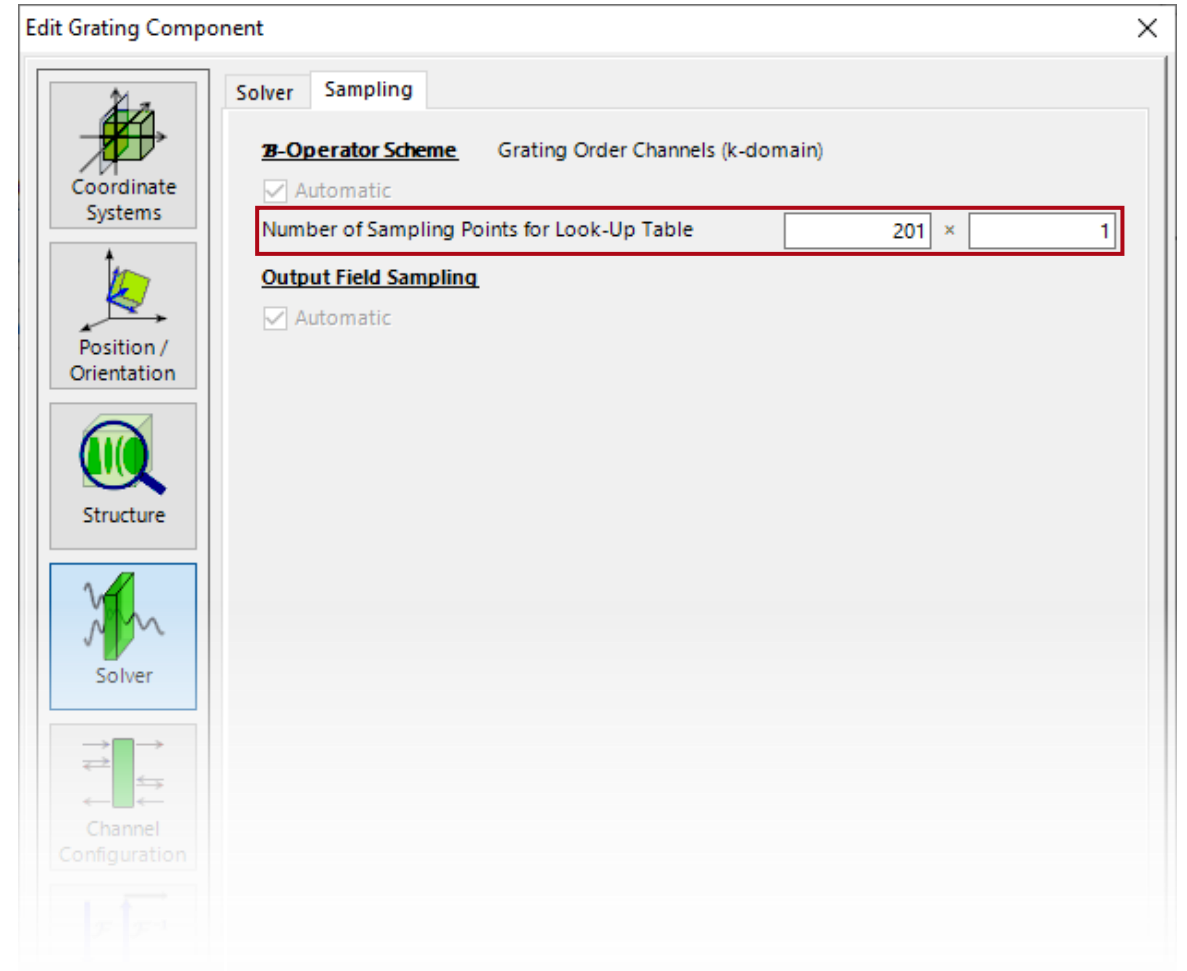
- Specific transmission and reflection orders can be defined for consideration in the simulation. It is also possible to have different orders for situations in which the surface is illuminated from the back side as well.
- It is not always necessary to consider all the diffraction orders, and we suggest to use only those of interest, to ensure a more efficient simulation.
- Selection of the grating order channels does not affect the internal number of diffraction orders in (i.e., the accuracy of) the FMM calculation.

select the orders in the system modeling



Angular Response of Grating

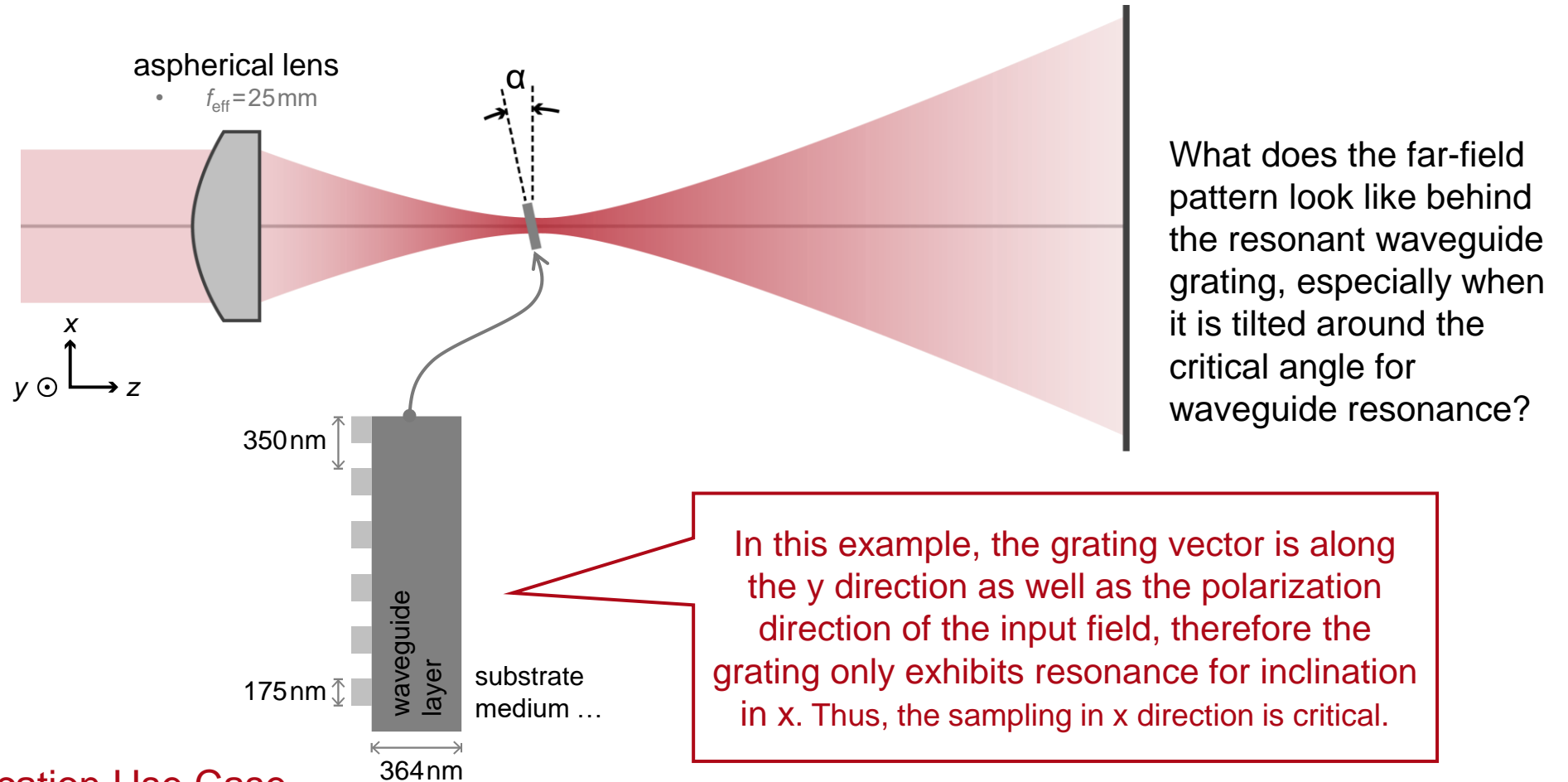
- In VirtualLab Fusion, the operator of the Grating component is modeled in the k-domain by FMM (aka RCWA).
- For a given grating, its diffractive behavior is related to the input field.
- With different wavelength/polarization, the diffraction efficiency varies, and the same for different input angles.
- To resolve the angle-dependent diffraction behavior, one may need to specify the sampling points in the k-domain (angular space). See the following example for further clarification.



Example: Angular Response of Resonant Waveguide Grating

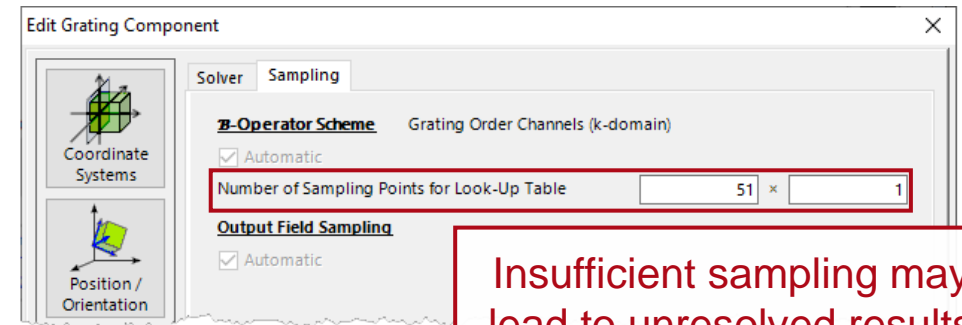
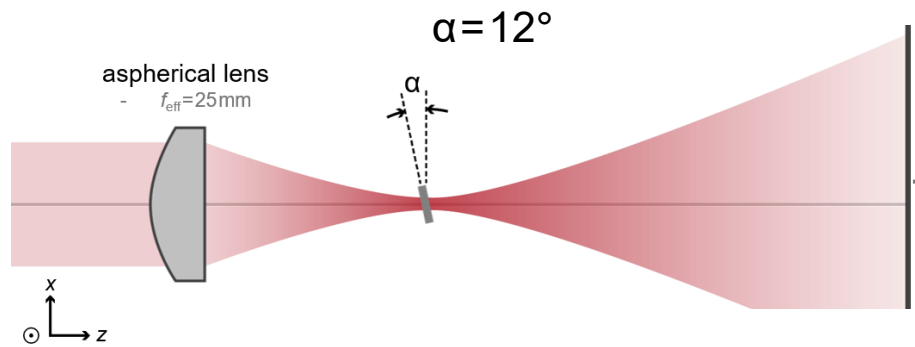
input field

- fundamental Gaussian
- beam diameter 2mm
- wavelength $\lambda=632.8\text{nm}$
- polarization along y (TE)



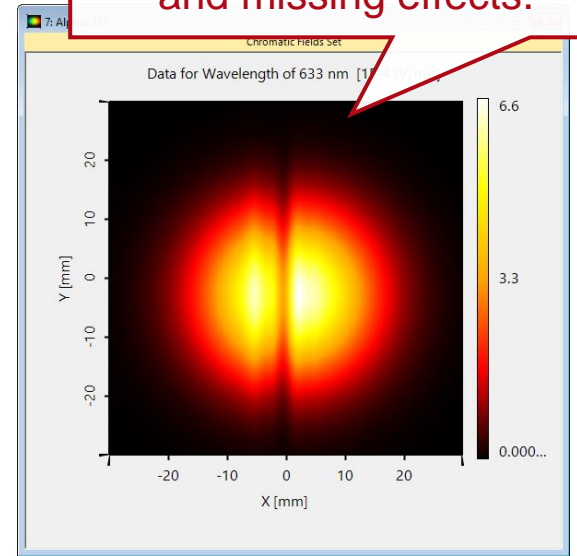
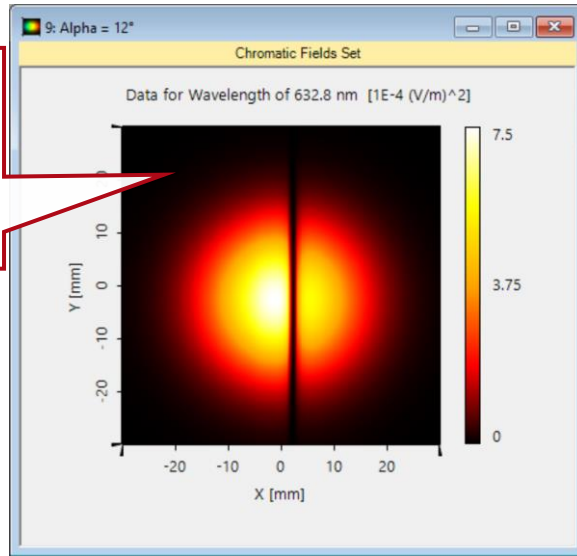
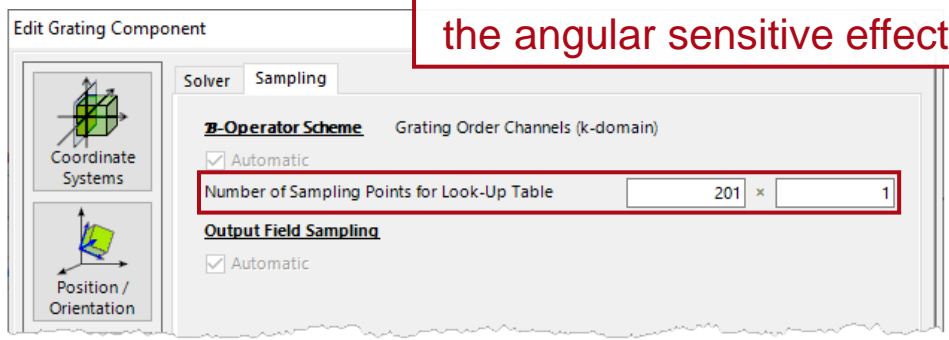
[➔ See the full Application Use Case](#)

Angular Response of Resonant Waveguide Grating



Insufficient sampling may lead to unresolved results and missing effects.

A high enough number of sampling points in k-domain ensures the resolution of the angular sensitive effect.



Document Information

title	Grating Component for General Optical Systems
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document version	2.0
software edition	VirtualLab Fusion Advanced
software version	2021.1 (Build 1.180)
category	Feature Use Case
further reading	<ul style="list-style-type: none">- Configuration of Grating Structures by Using Interfaces- Configuration of Grating Structures by Using Special Media- VirtualLab Fusion Technology FMM / RCWA [S Matrix]- Czerny-Turner Setup