Scenario 87.01 : Simulation of Gratings with Rough Surface

The simulation of a sinusoidal grating with a rough random surface will be demonstrated. The simulation is done using the programmable interface in a stack on the General Grating 2D component of VirtualLab.

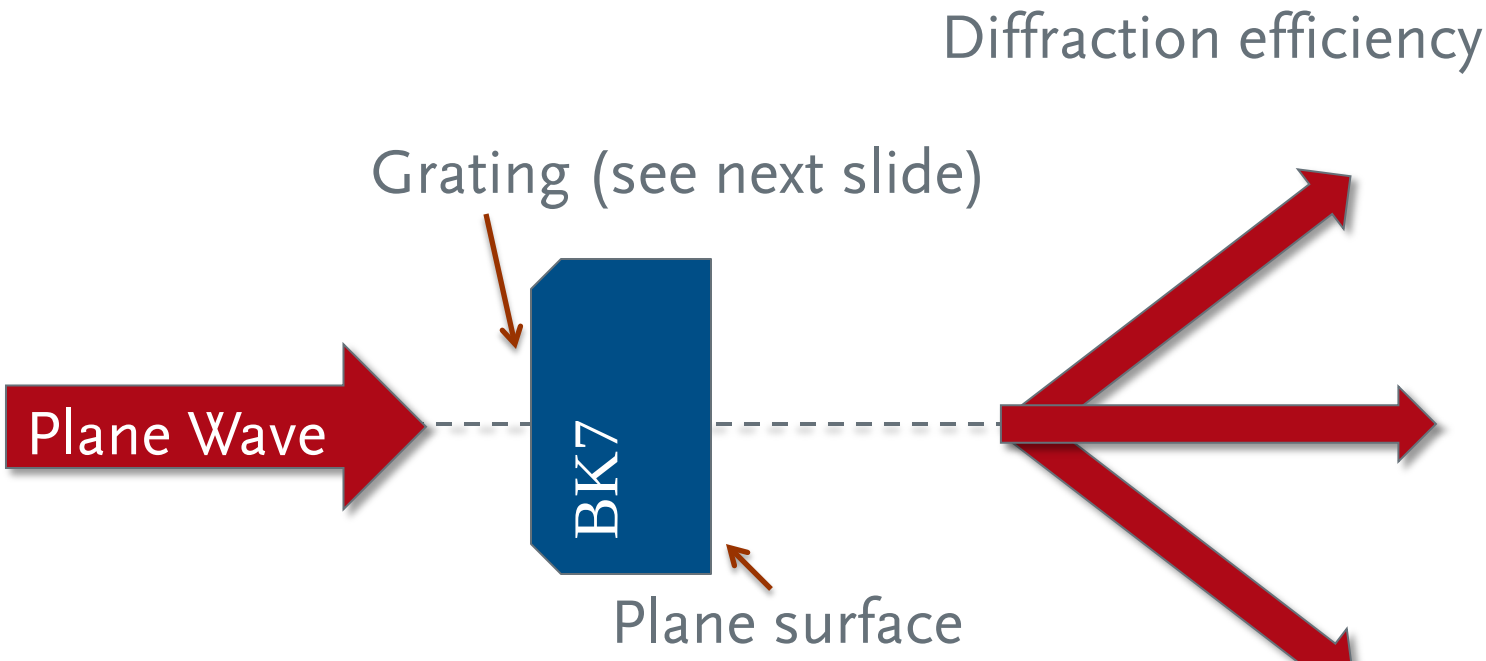
Keywords: gratings, grating toolbox, rough surfaces, programmable interface, grating component

Required Toolboxes: Grating Toolbox

Related Application Scenarios: Scenario 090.01, Scenario 246.01

LIGHTTRANS

Modeling Task



Incident angle: 0°
Wavelength: 532 nm

Description of the Grating

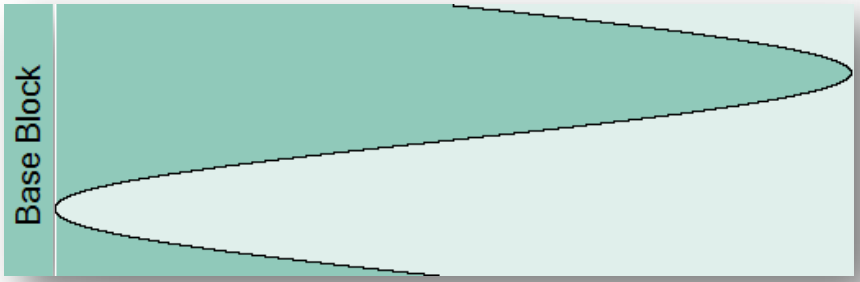
- The original surface profile is a smooth sinusoidal profile with a period of 5 μm and a modulation depth of 468 nm (results in same efficiency for innermost three orders).
- This sinusoidal profile is superimposed with random variations, modeled with the programmable interface of VirtualLab™.
- The snippet for modeling the roughness has two physical parameters: the *Smallest Feature Size* and the *Total Height Modulation*. With the *Seed* variable you can fix the random number generator to obtain reproducible results.

Variation of „Smallest Feature Size“

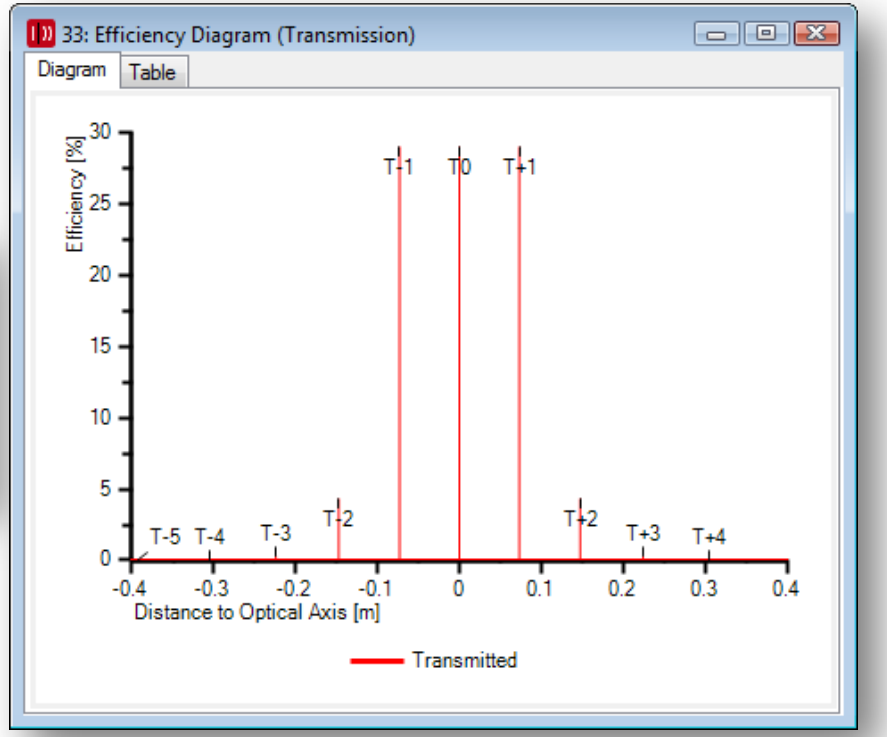
The following slides show the resulting height profiles as well as the resulting efficiency diagrams for a “Total Height Modulation” of 50 nm and different values for the “Smallest Feature Size”.

„Smallest Feature Size“ of 0 nm

Height Profile

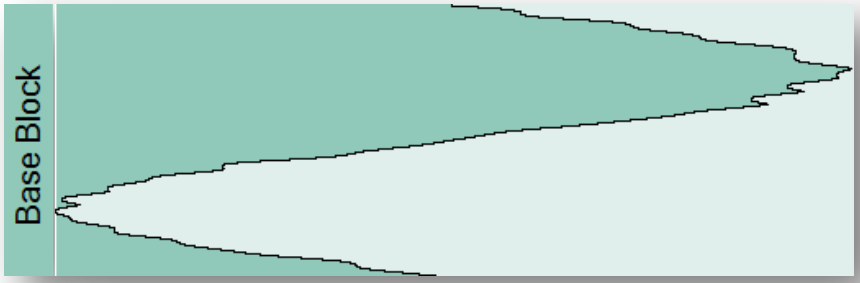


Efficiency Diagram

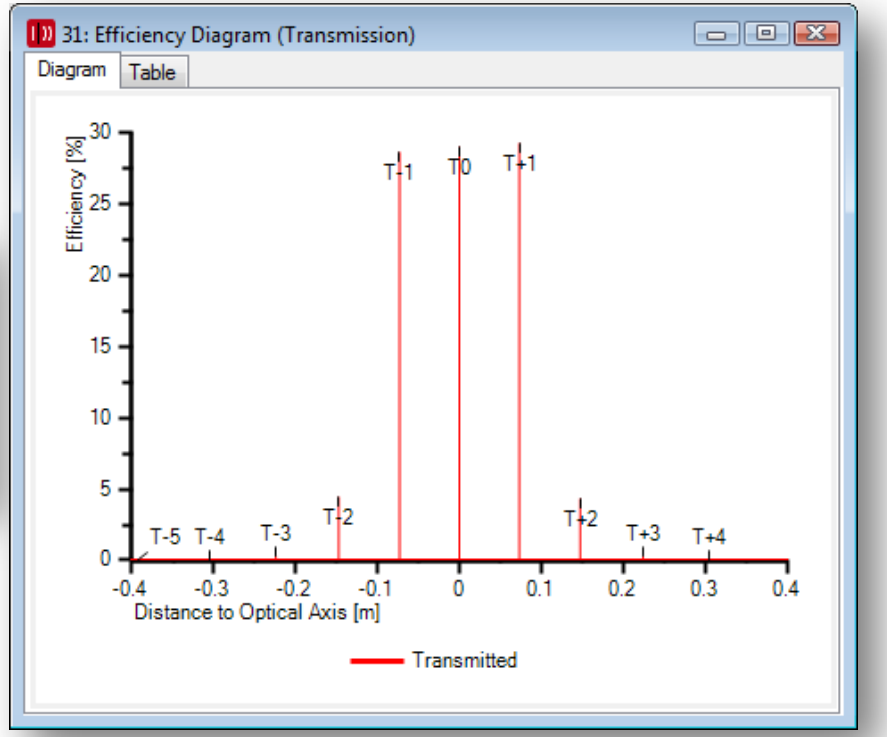


„Smallest Feature Size“ of 100 nm

Height Profile

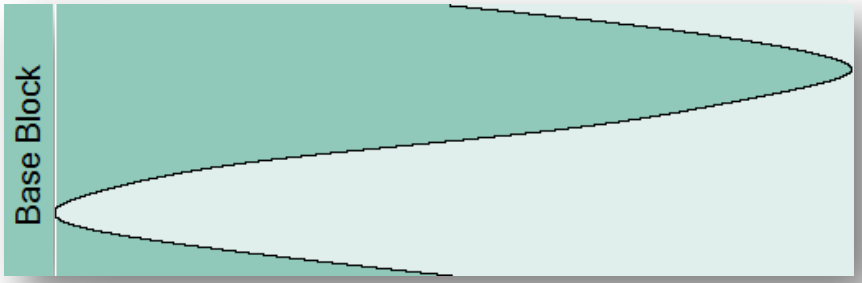


Efficiency Diagram

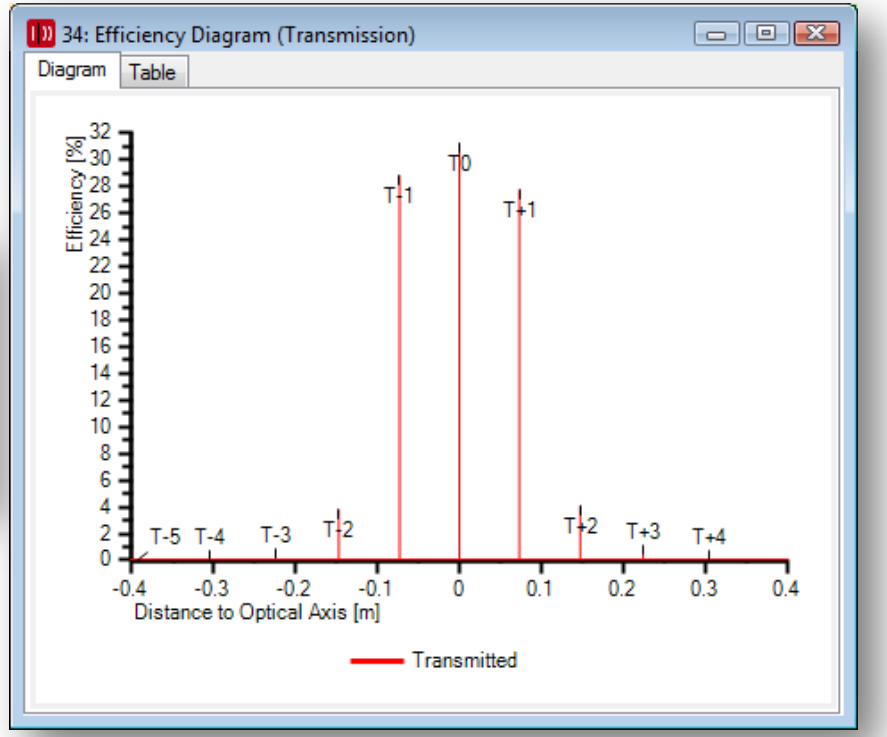


„Smallest Feature Size“ of 500 nm

Height Profile

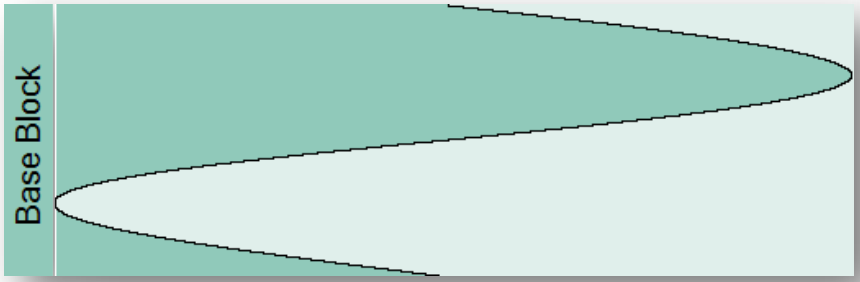


Efficiency Diagram

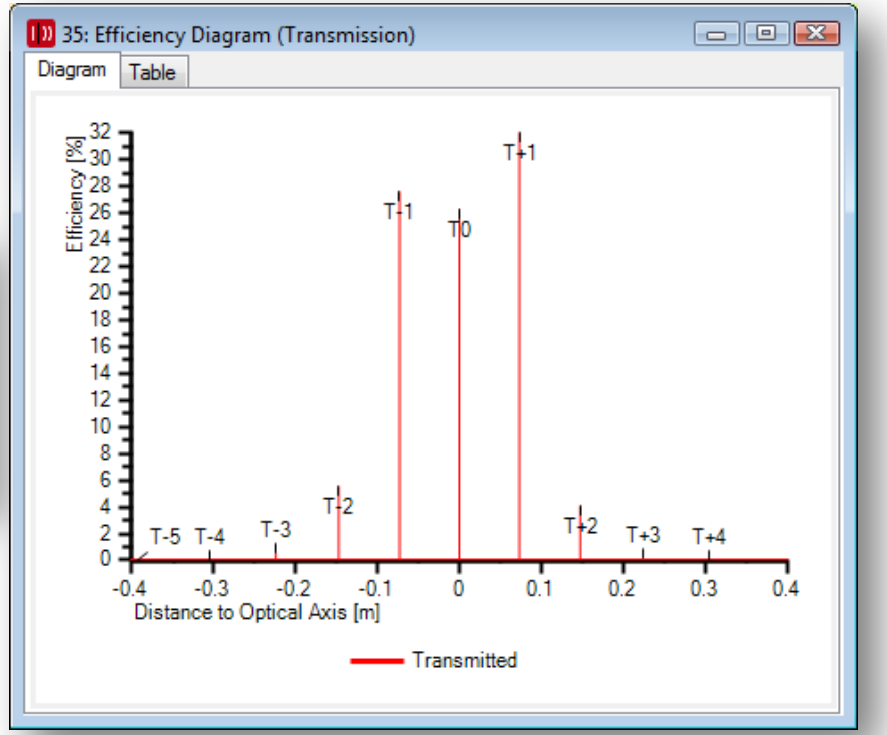


„Smallest Feature Size“ of 1000 nm

Height Profile

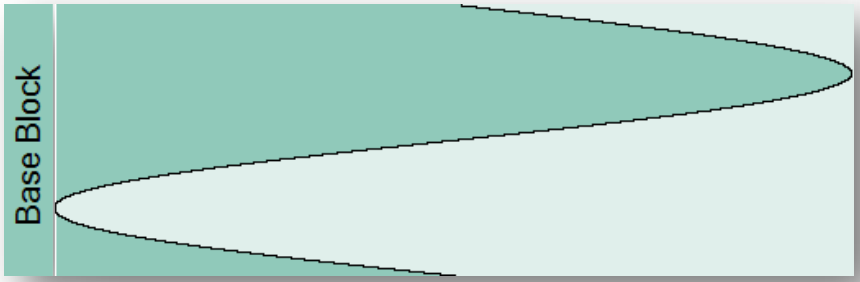


Efficiency Diagram

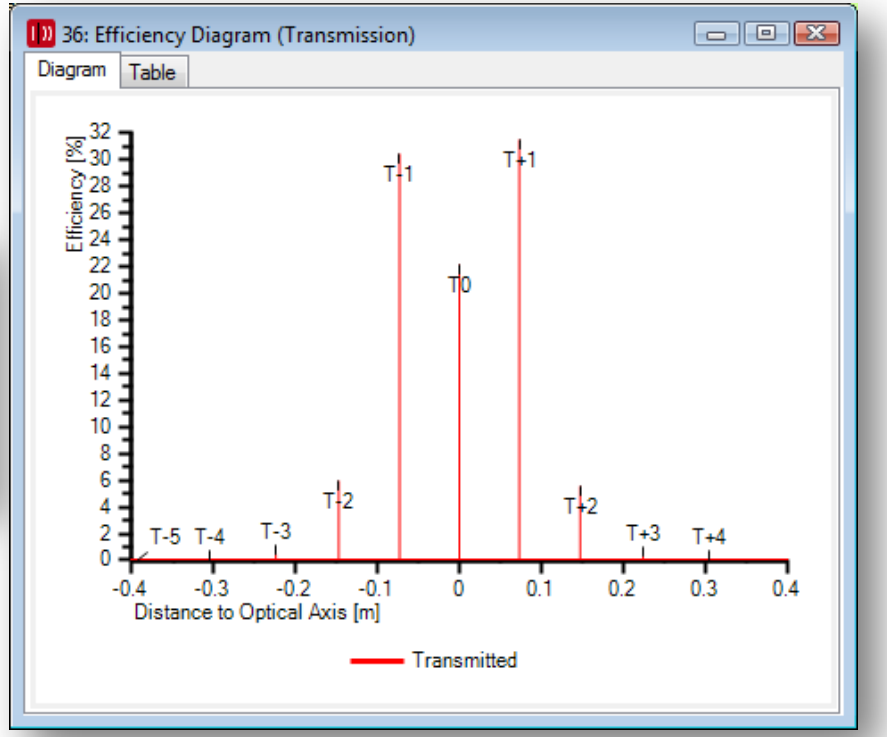


„Smallest Feature Size“ of 1500 nm

Height Profile



Efficiency Diagram

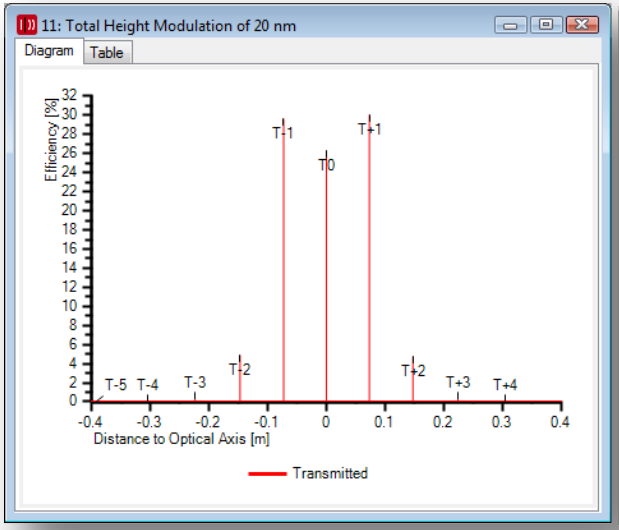


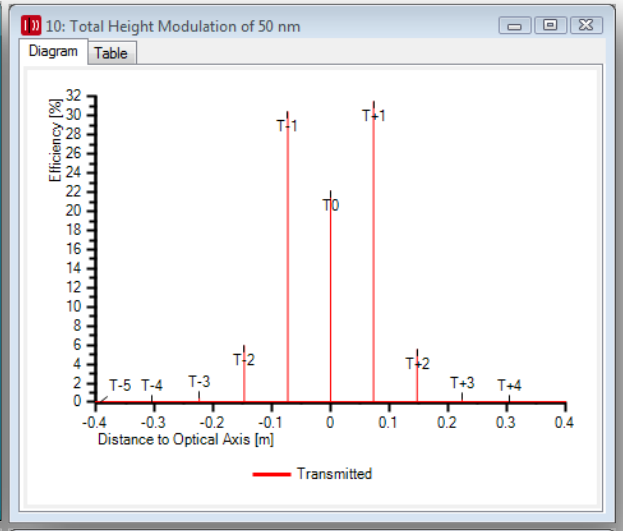
Parameter Runs

- The file *Scenario_087.01_Grating_with_Rough_Surface__Smallest_Feature_Size.run* contains a run over various values for the “Smallest Feature Size” for a “Total Height Modulation” of 50 nm.
- In contrast, the file *Scenario_087.01_Grating_with_Rough_Surface__Total_Height_Modulation.run* varies the “Total Height Modulation” for a “Smallest Feature Size” of 1.5 µm. Some results of this variation are shown on the next slide.

Results for different “Total Height Modulations”

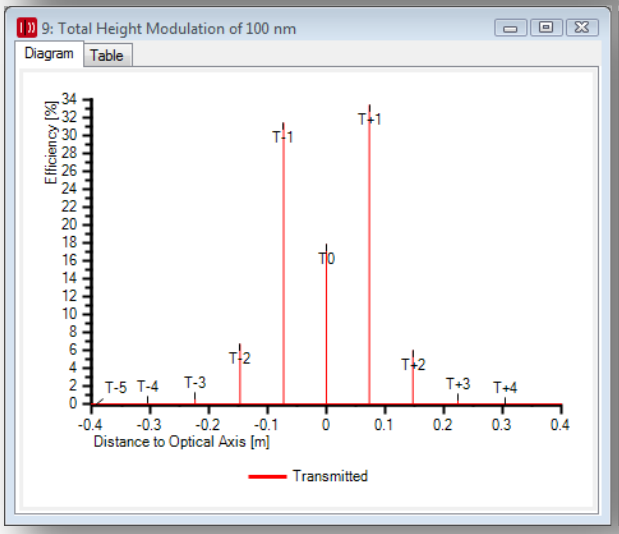
20 nm

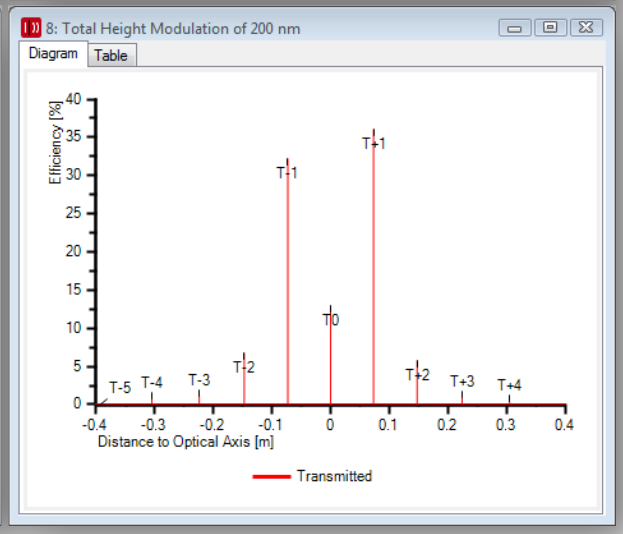




50 nm

100 nm





200 nm

Conclusion

- VirtualLab™ allows the rigorous simulation of surface gratings with rough height profile.
- The programmable interface can be used for the simulation of gratings with user defined height profiles
- Especially large modulations (in x- and y-direction) lead to strong deviations from the original diffraction pattern.