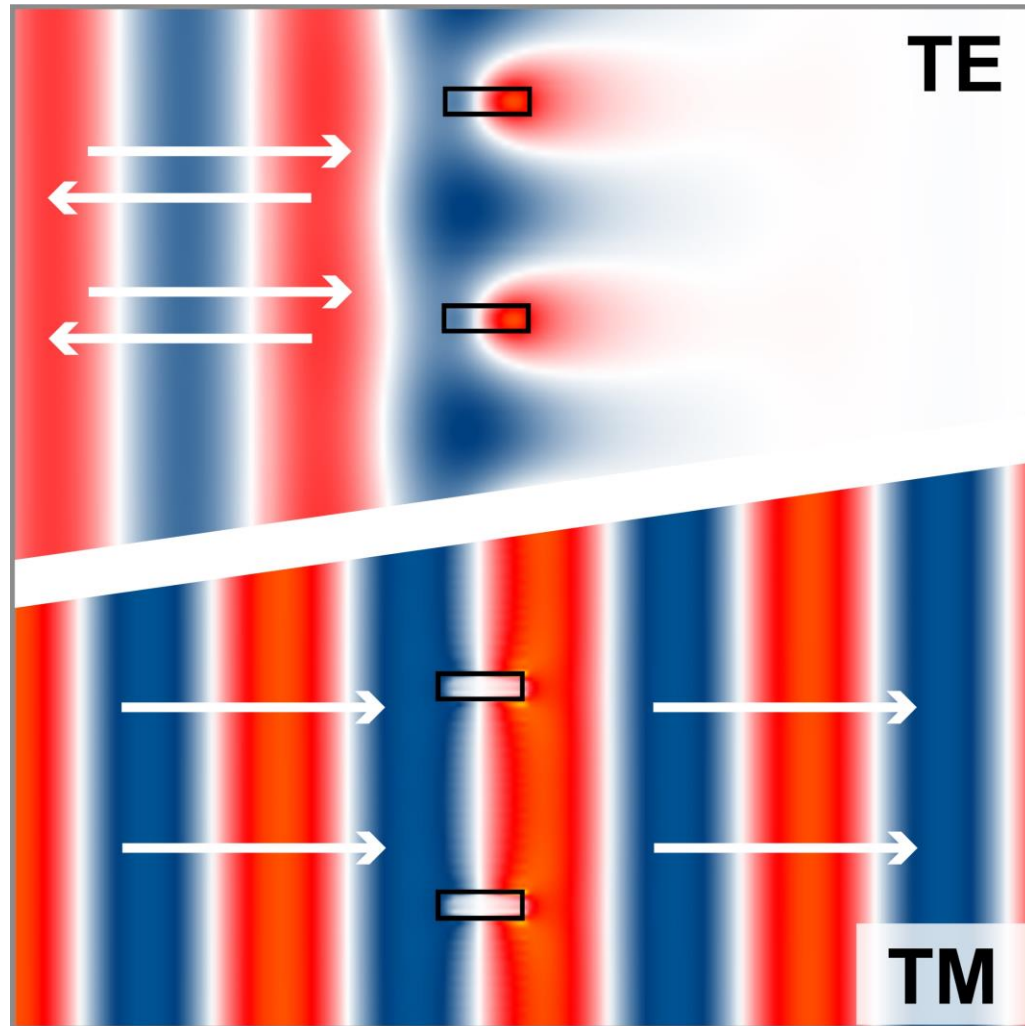


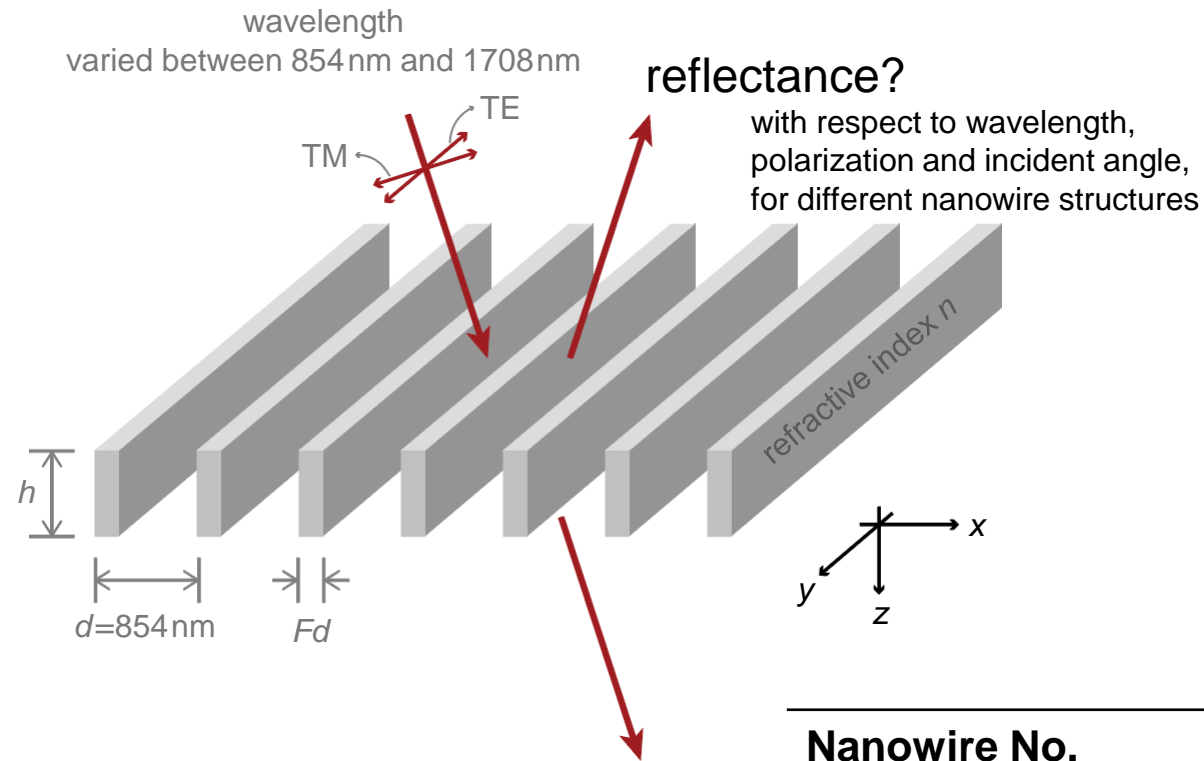
Ultra-Sparse Dielectric Nano-Wire Grid Polarizer

Abstract



Ultra-sparse dielectric nanowire grids show strongly polarization-dependent properties and can therefore be employed as wideband reflectors [J. W. Yoon *et al.*, *Opt. Express* **23**, 28849-28856 (2015)]. The polarization-, wavelength-, and angle-dependent properties of selected nanowire grids are investigated by using the Fourier modal method (FMM, also known as RCWA). Visualization of the interaction between electric field and the nanowire grids are presented.

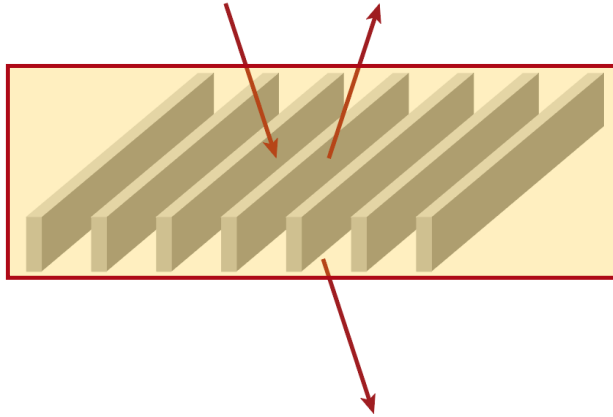
Modeling Task



Nanowire No.	#1	#2	#3
refractive index n	10	7.07	3.16
height h	269nm	270nm	292nm
filling factor F	0.01	0.02	0.1

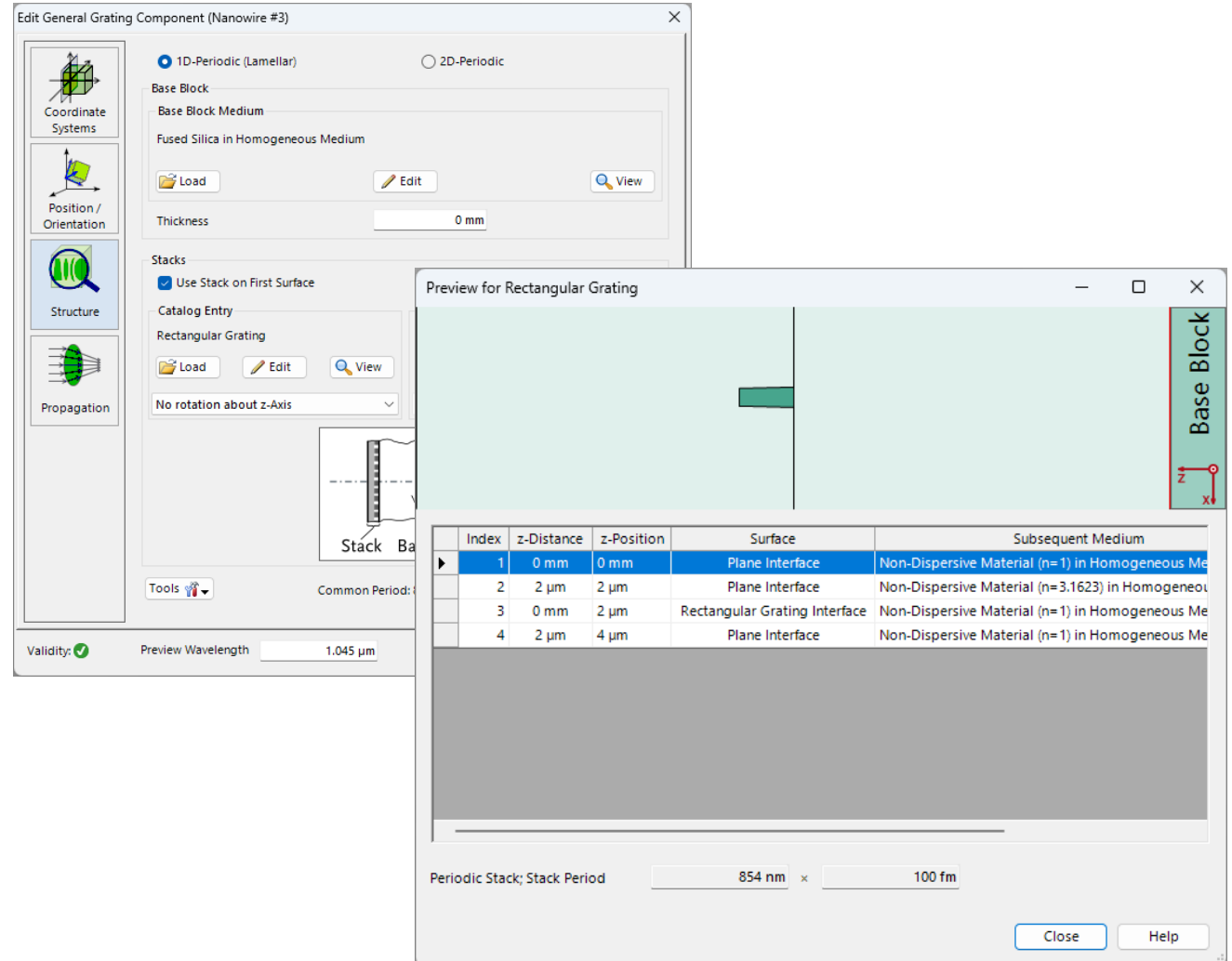
Parameters are taken from reference paper: J. W. Yoon *et al.*, Opt. Express **23**, 28849-28856 (2015).

Nanowire



Arbitrary periodic structures (containing multiple surfaces) can be defined and saved as *Stacks*. These *Stacks* then can be added to a *General Grating Component* for analysis.

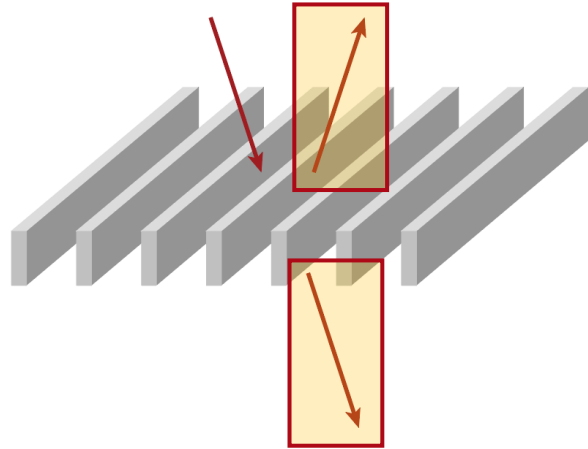
 Configuration of Grating Structures by Using Interfaces



Index	z-Distance	z-Position	Surface	Subsequent Medium
1	0 mm	0 mm	Plane Interface	Non-Dispersive Material (n=1) in Homogeneous Me
2	2 μm	2 μm	Plane Interface	Non-Dispersive Material (n=3.1623) in Homogeneou
3	0 mm	2 μm	Rectangular Grating Interface	Non-Dispersive Material (n=1) in Homogeneous Me
4	2 μm	4 μm	Plane Interface	Non-Dispersive Material (n=1) in Homogeneous Me

Periodic Stack; Stack Period: 854 nm × 100 fm

Grating Order Analyzer

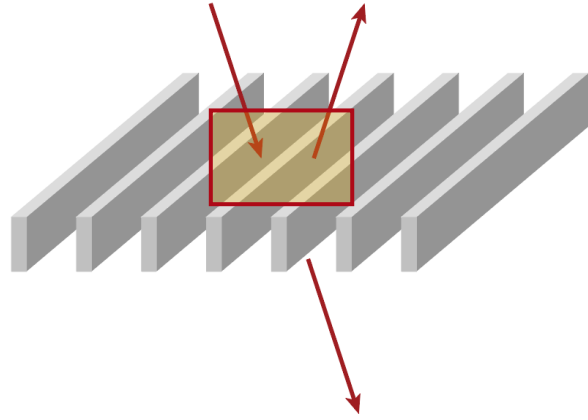


The *Grating Order Analyzer* is able to calculate the transmission/reflection efficiency of all/certain orders. For the periodic structure in this example, the selected output order is R0 and T0.

 [Grating Order Analyzer](#)

The image shows a screenshot of the software interface for the Grating Order Analyzer. At the top, a window titled "62: Optical Setup View #61" displays a schematic of the optical setup. It includes an "Ideal Plane Wave" (0), a "Nanowire #3" (1), a "Field Inside Component Analyzer: FMM" (801), and a "Grating Order Analyzer" (802). Two "Raw Data Detectors" (600 and 601) are connected to the output of the grating. The "Grating Order Analyzer" component is highlighted with a red box. Below the schematic, two "Edit Grating Order Analyzer" dialog boxes are shown. The left dialog box is on the "Single Orders" tab and shows the "Order Selection Strategy" set to "Order Range" with "Minimum Order" and "Maximum Order" both set to 0. The right dialog box is also on the "Single Orders" tab and shows the "Calculated Orders" section with "Reflection" checked and "Transmission" unchecked. The "Output" section has "Order Collections" and "Single Order Output" checked.

Field Inside Analyzer



The *Field Inside Component: FMM Analyzer* visualizes the field propagation in the defined micro- or nanostructure. In this example, the propagation inside the nanowire structure is investigated. For the output, the forward propagating modes, the backward propagating modes or all modes together can be selected.

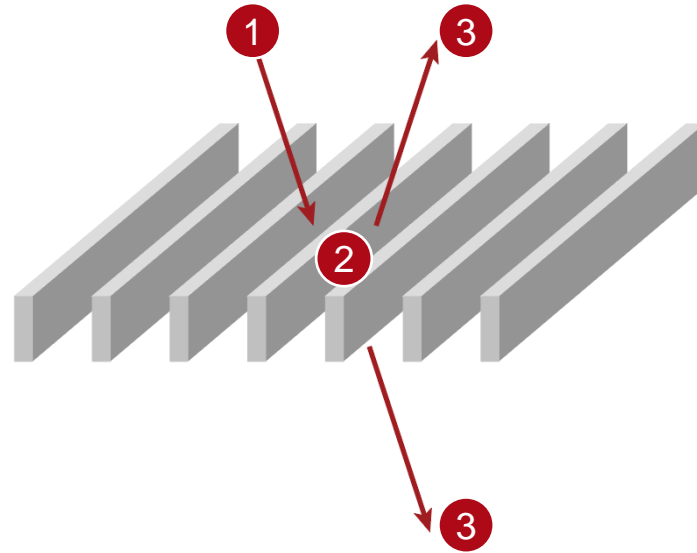
 [Field Inside Component Analyzer: FMM](#)

The image shows a screenshot of an optical simulation software interface. The main window displays an optical setup with the following components: an 'Ideal Plane Wave' (0) connected to a 'Nanowire #3' (1), which is connected to a 'Raw Data Detector' (600). A 'Field Inside Component Analyzer: FMM' (801) is connected to the Nanowire #3. Below the main setup, there are two 'Grating Order Analyzer' components (801 and 802). A dialog box titled 'Edit Field Inside Component Analyzer: FMM' is open, showing the following settings:

- Vectorial Component:** Ex-Component, Ey-Component, Ez-Component, Hx-Component, Hy-Component, Hz-Component
- Evaluated Modes:** Forward Propagating, Backward Propagating
- x-z-Region:** Number of Periods: 3, z-Range: Whole Component
- Sampling:** Sampling Points, Sampling Distance: 10 nm x 10 nm

The dialog box has 'OK', 'Cancel', and 'Help' buttons at the bottom.

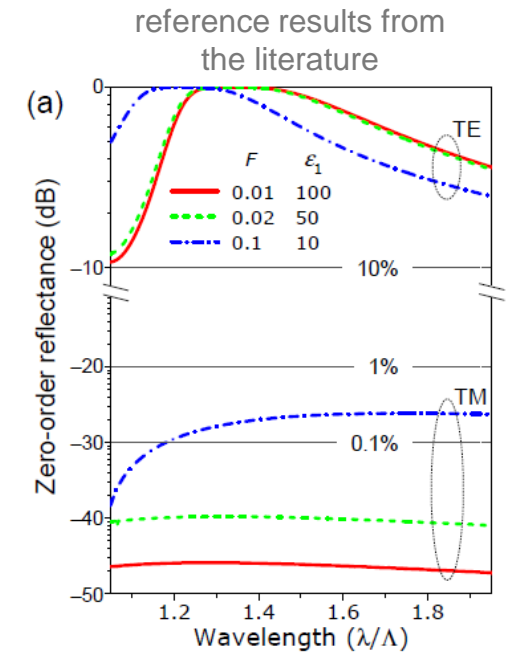
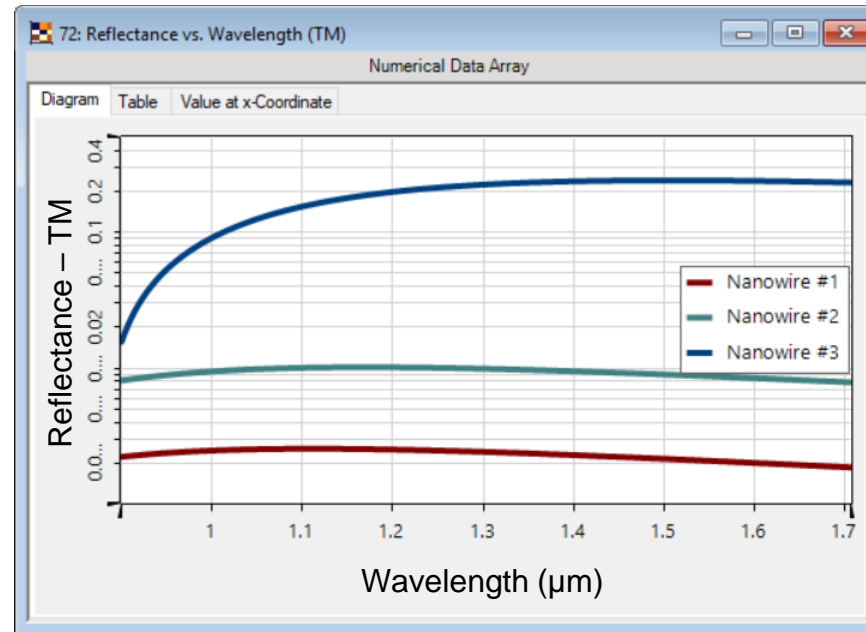
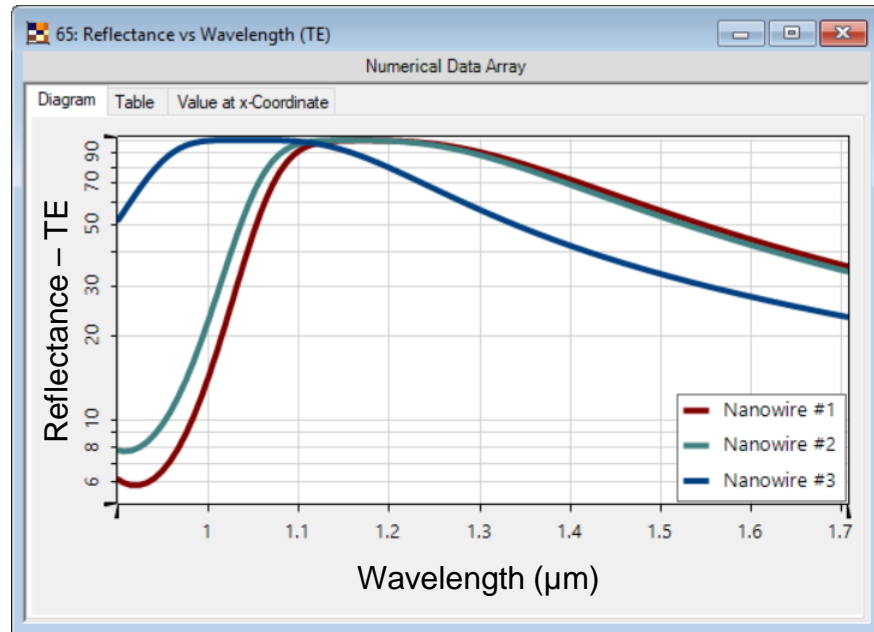
Summary – Components...



... of Optical System	... in VirtualLab Fusion	Model/Solver/Detected Value
1. source	<i>Ideal Plane Wave</i>	ideal Plane Wave
2. nanowire	<i>General Grating Component</i>	Fourier Modal Method (FMM) / Rigorous Coupled Wave Analysis (RCWA)
3. detector	<i>Grating Order Analyzer</i>	Fresnel coefficients & efficiencies

Parameter Scanning (1D)

Results of Fourier modal method (FMM) simulation in VirtualLab

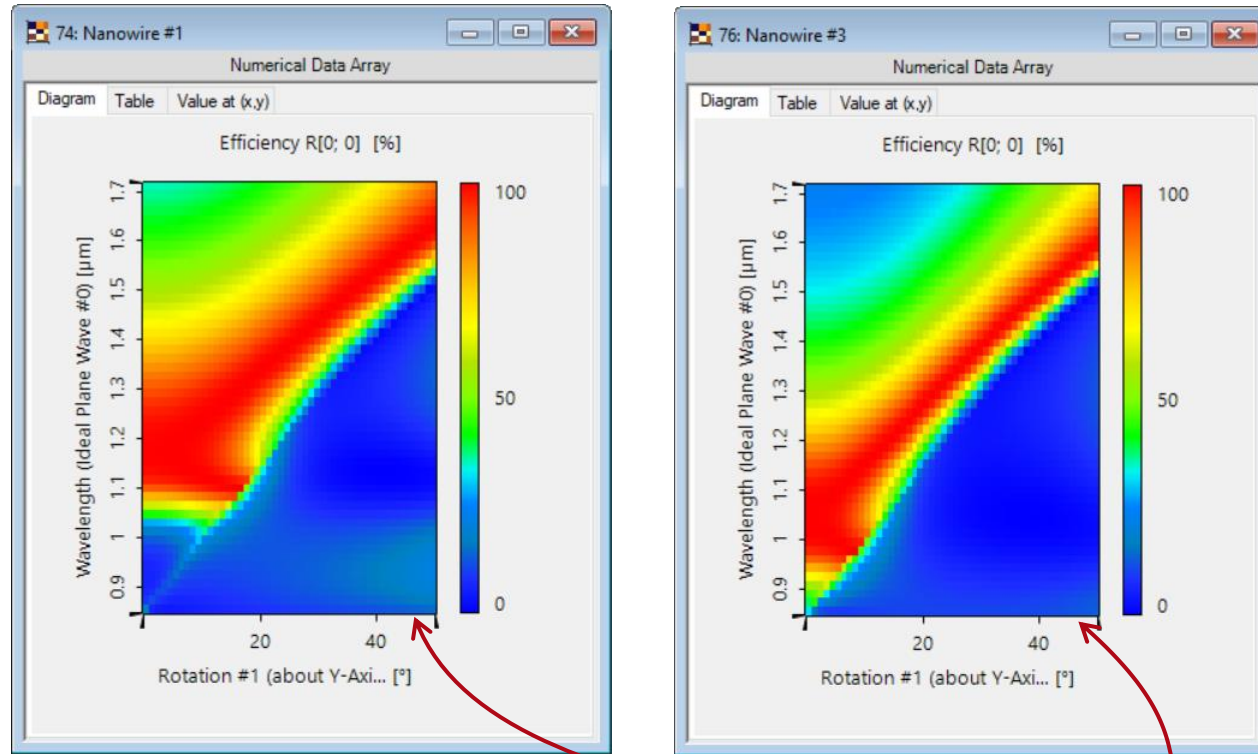


Nanowire No.	#1 —	#2 —	#3 —
refractive index n	10	7.07	3.16
height h	269nm	270nm	292nm
filling factor F	0.01	0.02	0.1

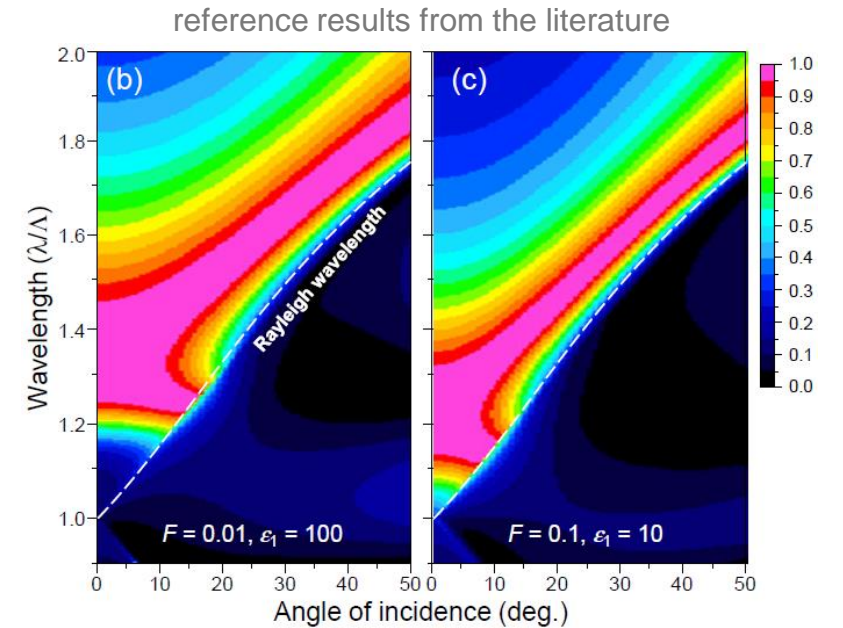
J. W. Yoon *et al.*, Opt. Express **23**, 28849-28856 (2015).

Parameter Scanning (2D)

Results of Fourier modal method (FMM) simulation in VirtualLab Fusion (TE polarized light)



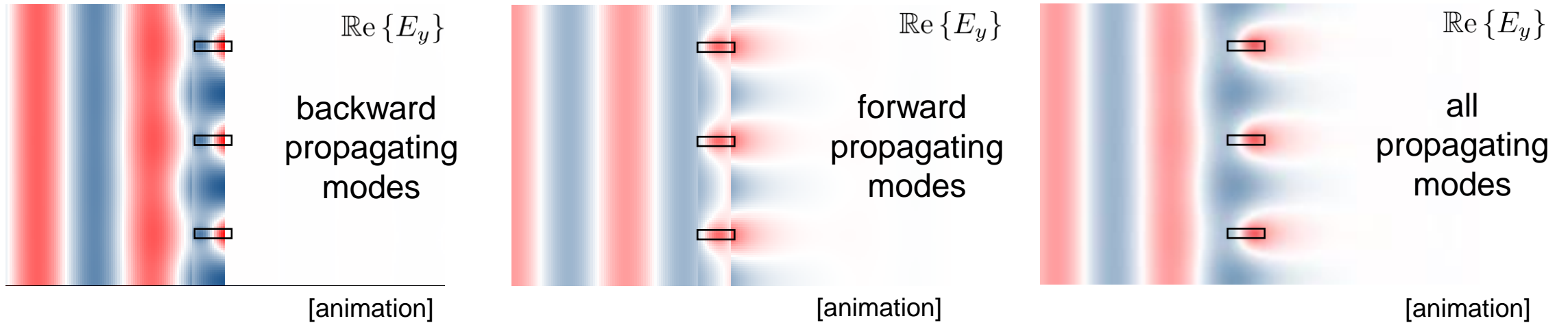
Nanowire No.	#1	#2	#3
refractive index n	10	7.07	3.16
height h	269nm	270nm	292nm
filling factor F	0.01	0.02	0.1



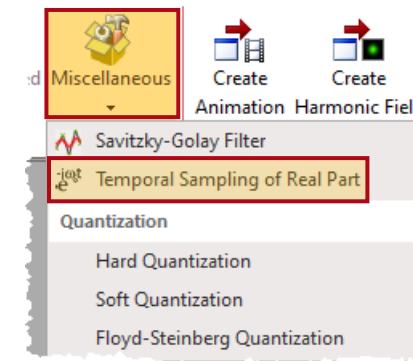
J. W. Yoon *et al.*, Opt. Express **23**, 28849-28856 (2015).

Visualization of Field Inside Grating - TE

Results of Fourier modal method (FMM) simulation in VirtualLab Fusion (@1045 nm wavelength)



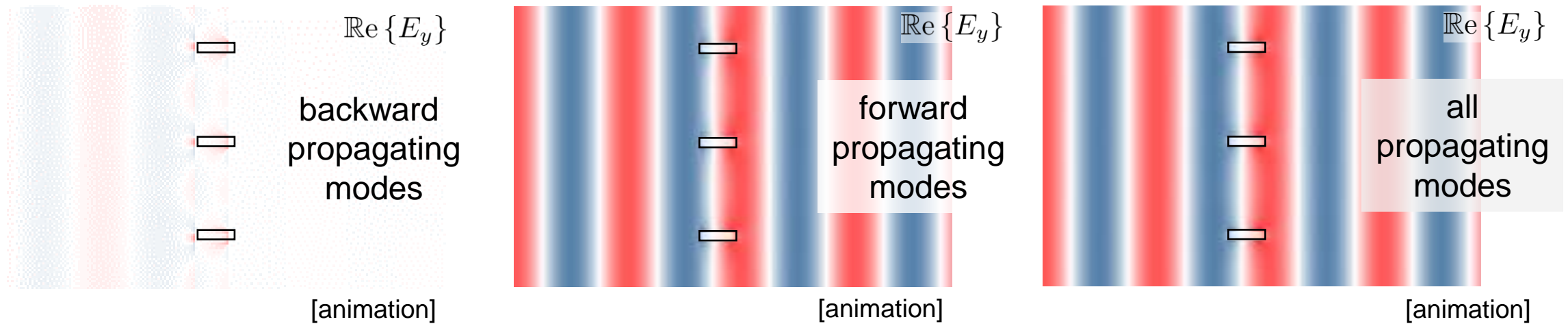
Nanowire No.	#1	#2	#3
refractive index n	10	7.07	3.16
height h	269nm	270nm	292nm
filling factor F	0.01	0.02	0.1



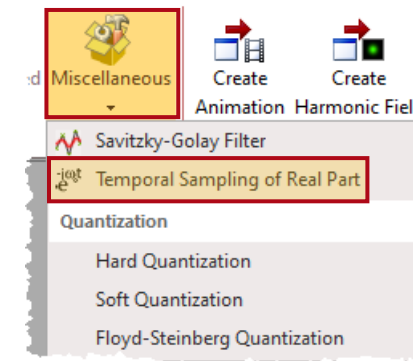
Note: The *Temporal Sampling of Real Part* function of the *Miscellaneous* section in *Manipulations* can be used to visualize the propagation of the field in the component.

Visualization of Field Inside Grating - TM

Results of Fourier modal method (FMM) simulation in VirtualLab Fusion (@1045 nm wavelength)



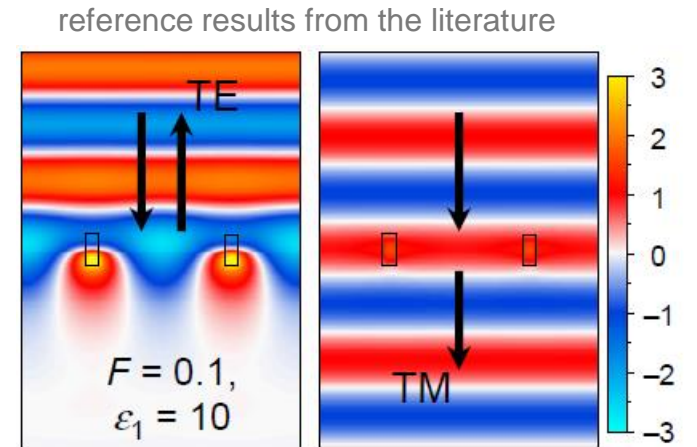
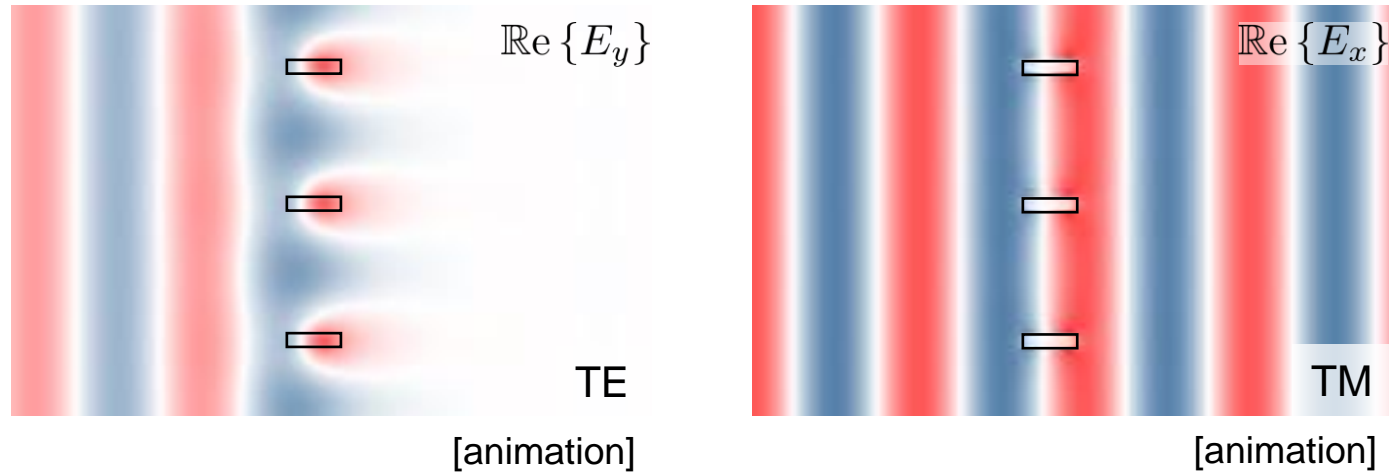
Nanowire No.	#1	#2	#3
refractive index n	10	7.07	3.16
height h	269nm	270nm	292nm
filling factor F	0.01	0.02	0.1



Note: The *Temporal Sampling of Real Part* function of the *Miscellaneous* section in *Manipulations* can be used to visualize the propagation of the field in the component.

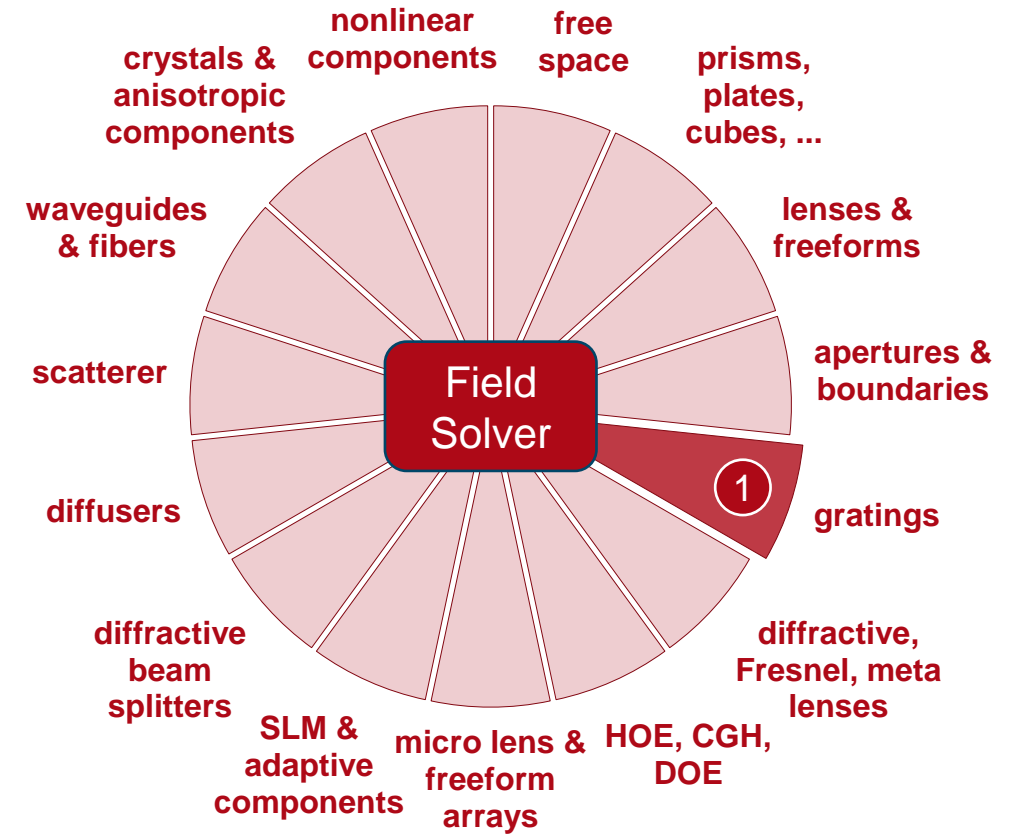
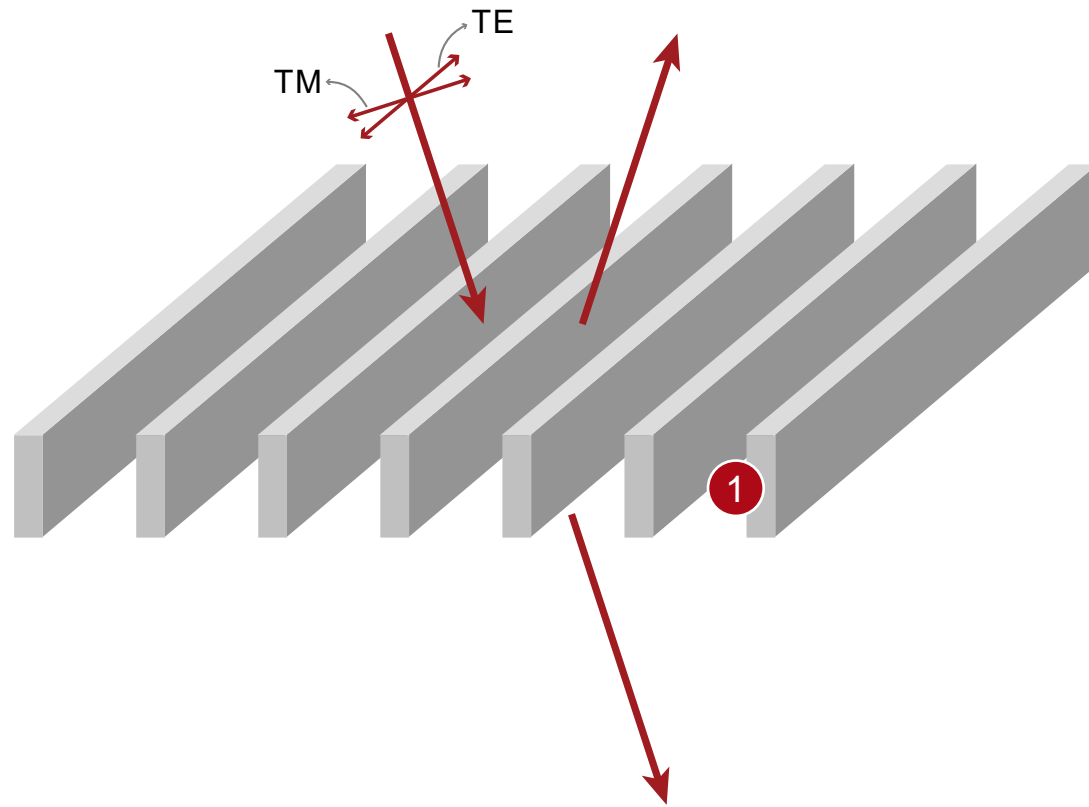
Comparison with reference

Results of Fourier modal method (FMM) simulation in VirtualLab Fusion (@1045 nm wavelength)



Nanowire No.	#1	#2	#3
refractive index n	10	7.07	3.16
height h	269nm	270nm	292nm
filling factor F	0.01	0.02	0.1

VirtualLab Fusion Technologies



Document Information

title	Ultra-Sparse Dielectric Nano-Wire Grid Polarizers
document code	GRT.0006
document version	2.0
software edition	VirtualLab Fusion Advanced
software version	2023.1 (Build 1.556)
category	Application Use Case
further reading	<ul style="list-style-type: none">• <u>Grating order analyzer</u>• <u>Rigorous Analysis and Design of Anti-Reflective Moth-Eye Structures</u>• <u>Rigorous Analysis of Nanopillar Metasurface Building Block</u>