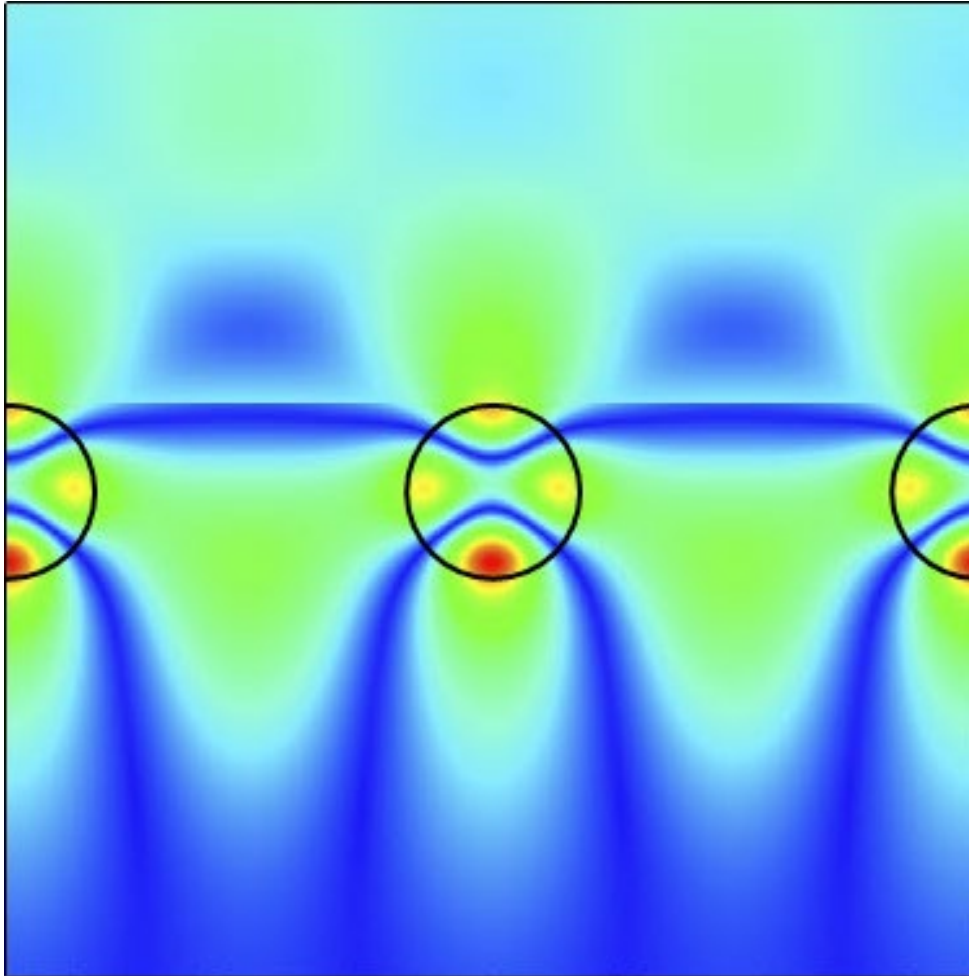


# Resonant Photonic Lattices

# Abstract



Resonant periodic nanostructures are a prime example to be calculated with Fourier Modal Method (FMM) – algorithms, due to their small periods. Hence, in this Use Case, we want to simulate a photonic lattice system with the in-built FMM solver of VirtualLab Fusion. There the wavelength dependent reflectivity, as well as the field in and around the structure for various point of interest will be analyzed.

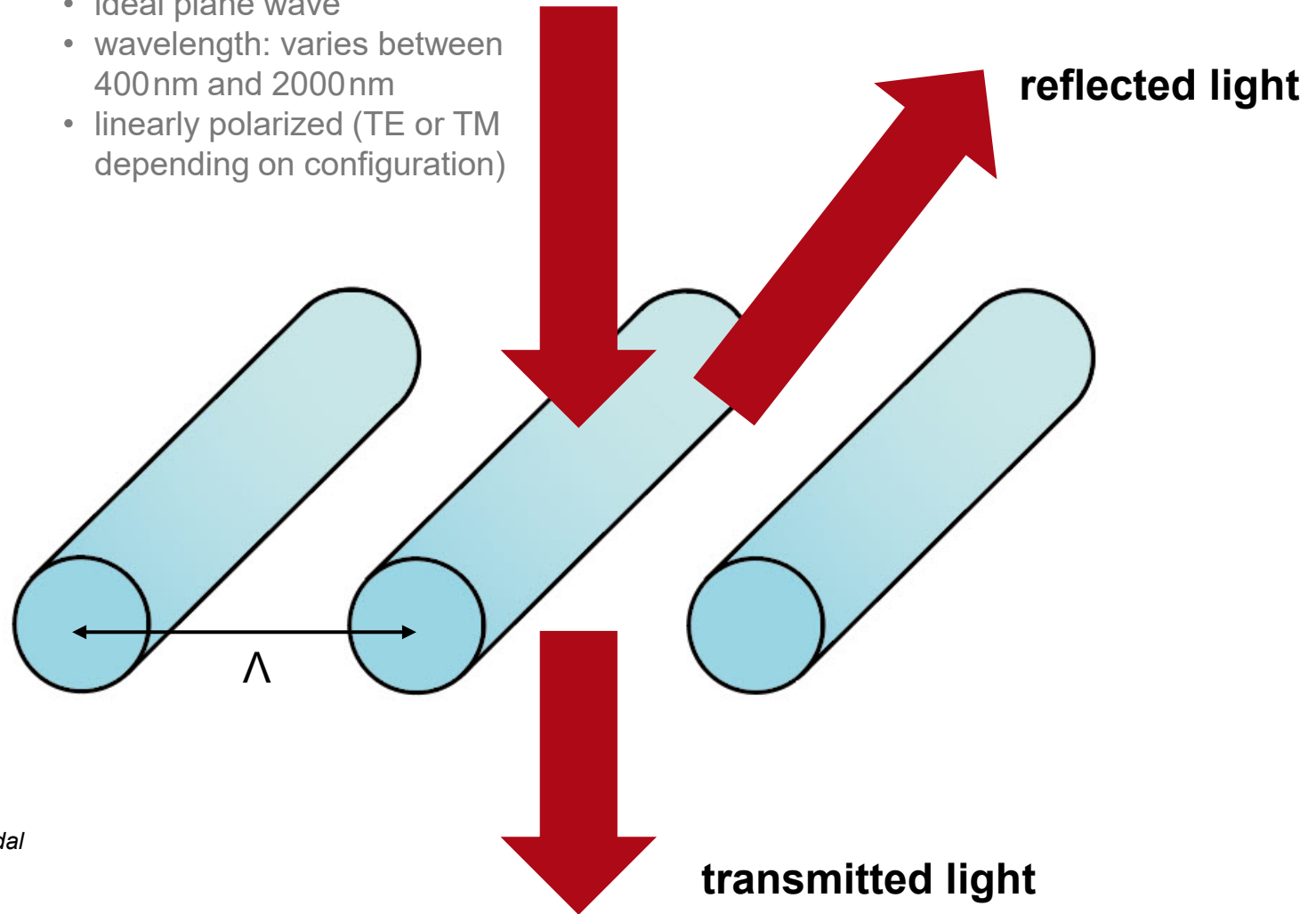
# Modeling Scenario

## source

- ideal plane wave
- wavelength: varies between 400nm and 2000nm
- linearly polarized (TE or TM depending on configuration)

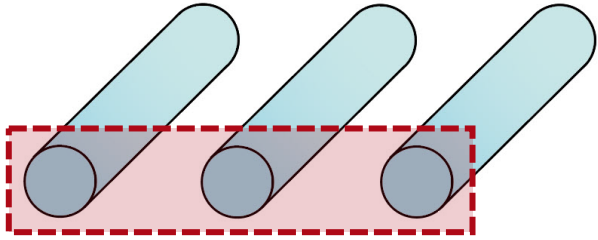
## photonic lattices

- 1D lamellar grating
- invariant in y-direction
- refractive index of cylinders: 3.5
- 3 configuration with different period  $\Lambda$ : 500nm, 700nm and 1100nm



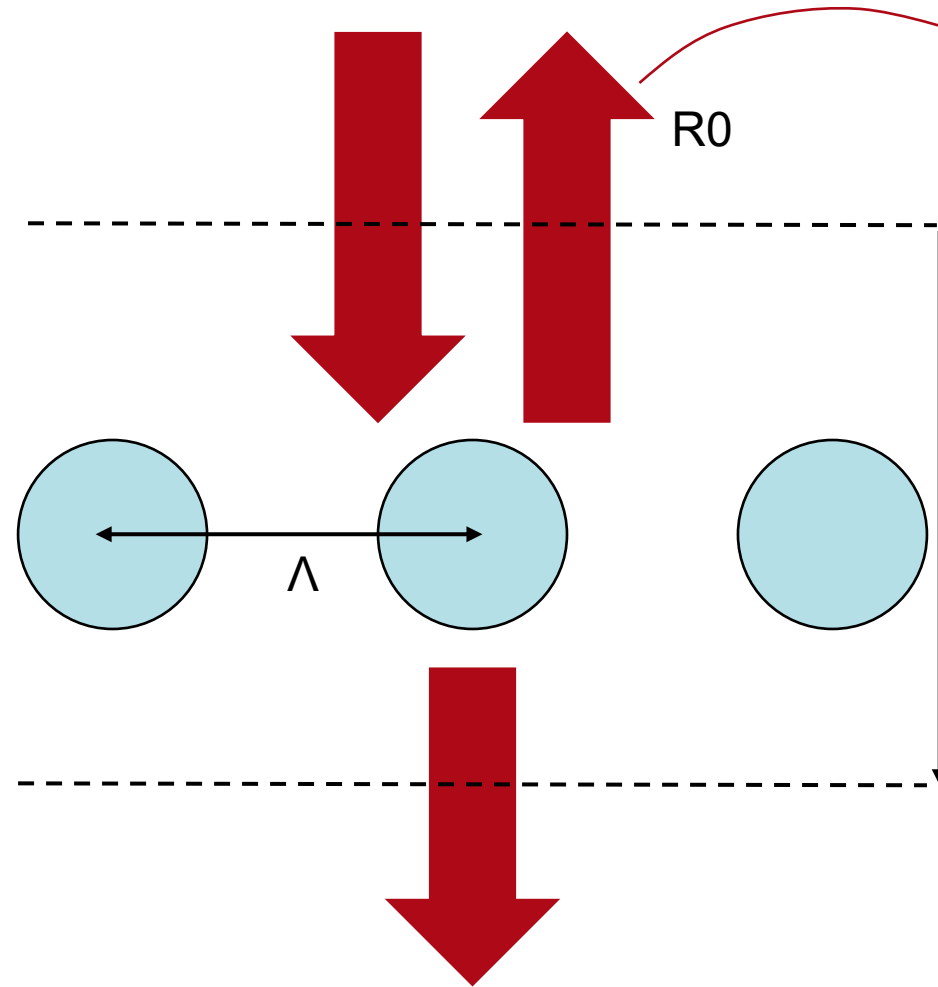
Reference: Yeong Hwan Ko, Nasrin Razmjooei, Hafez Hemmati, and Robert Magnusson, "Perfectly-reflecting guided-mode-resonant photonic lattices possessing Mie modal memory," *Opt. Express* **29**, 26971-26982 (2021)

# Modeling Task



## 3 different configurations

- a) TM-polarized source, 500 nm period
- b) TE-polarized source, 1100 nm period
- c) TE-polarized source, 700 nm period



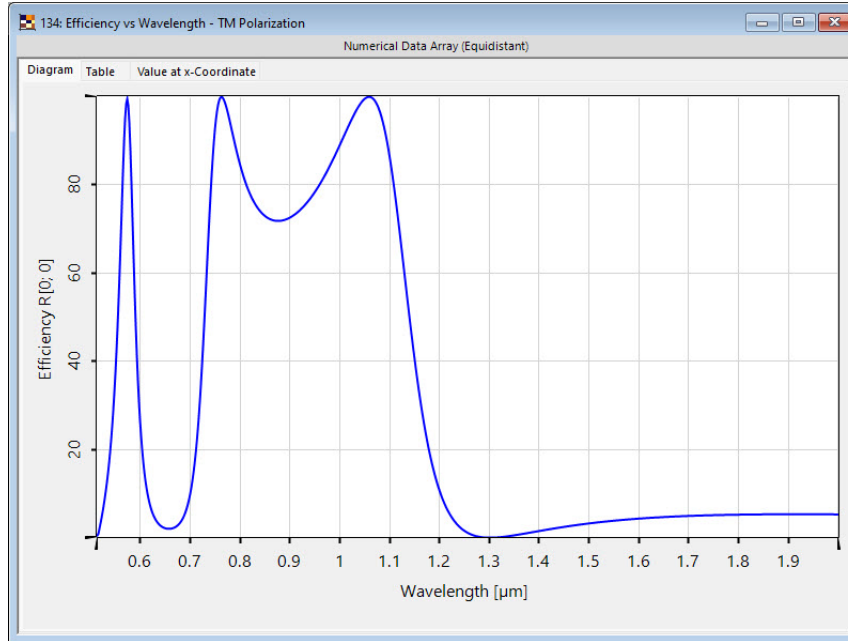
**Task 1:** wavelength dependency of the 0<sup>th</sup> reflection order for all 3 configurations

**Task 2:** detection of the field inside and near around the cylinders at wavelengths that provide high reflectivity.

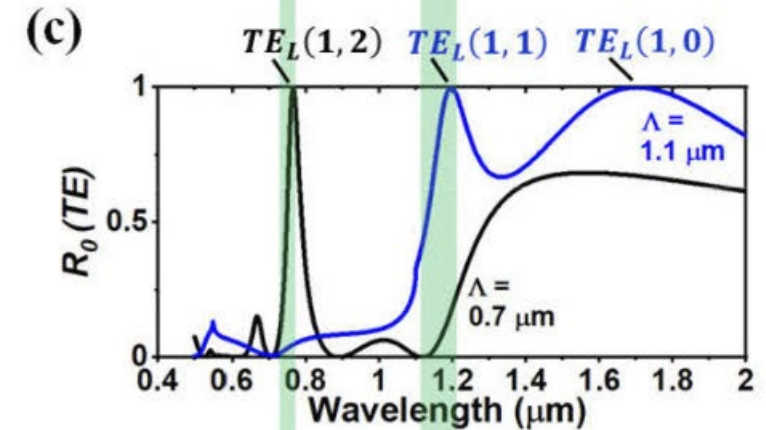
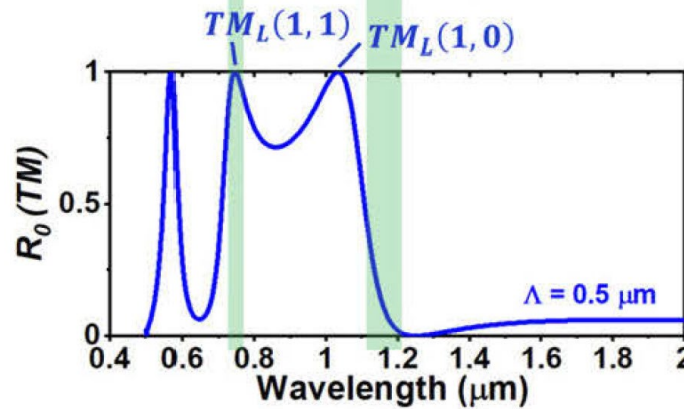
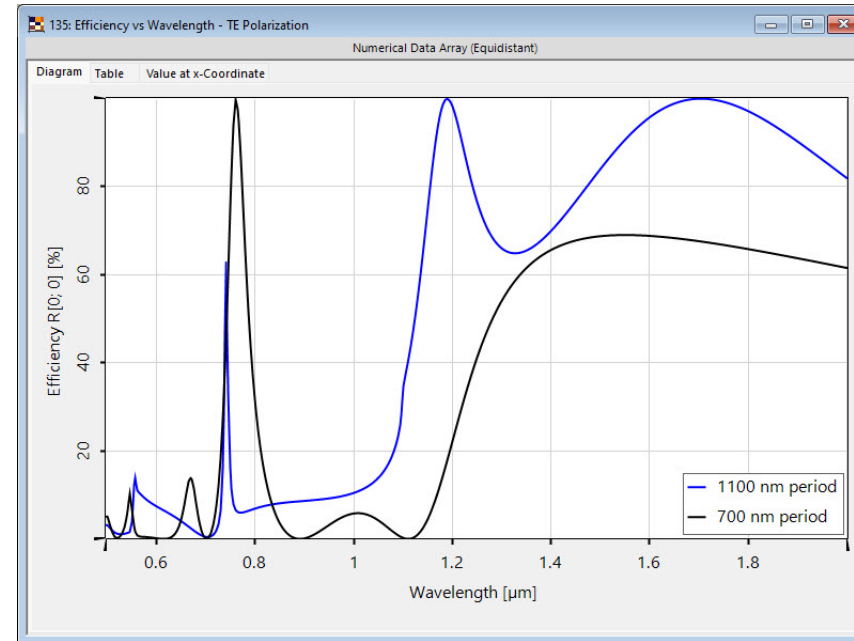
# Simulation Results

# Task 1 – Wavelength Dependency of the Reflection

configuration a  
TM-polarized  
source,  
500 nm period

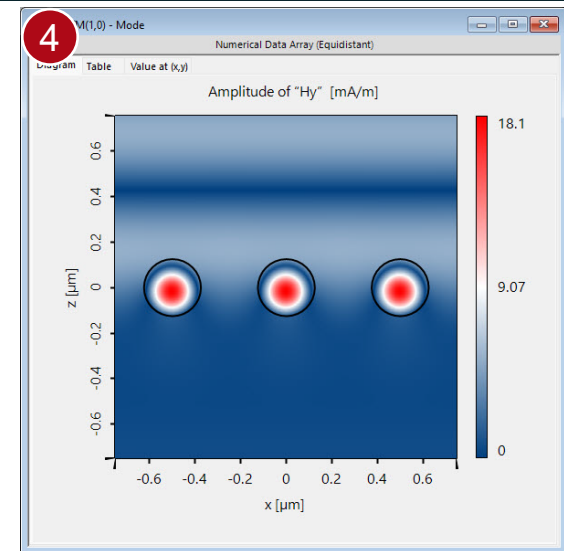
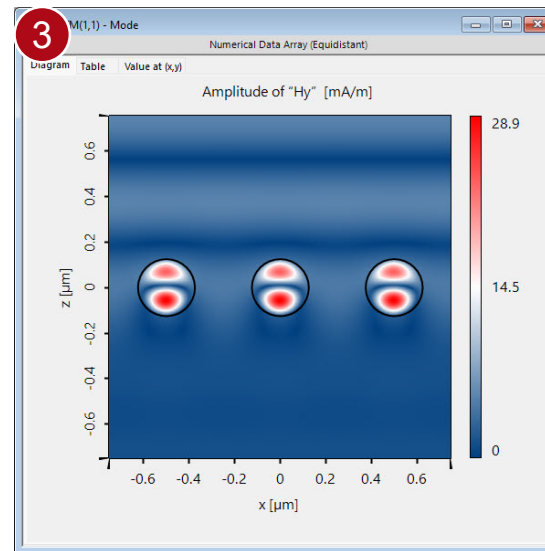
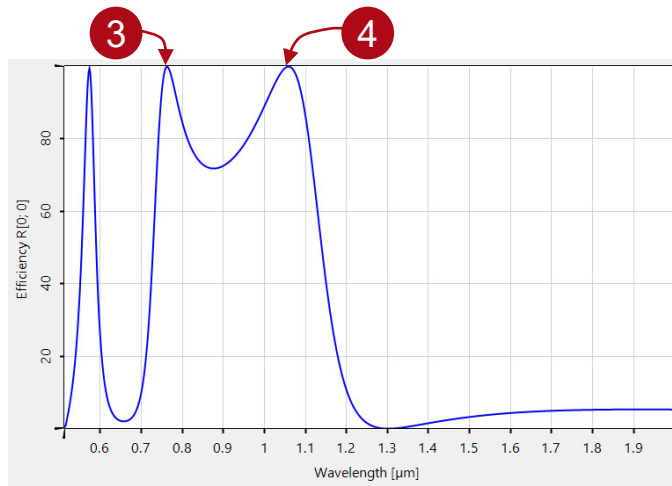
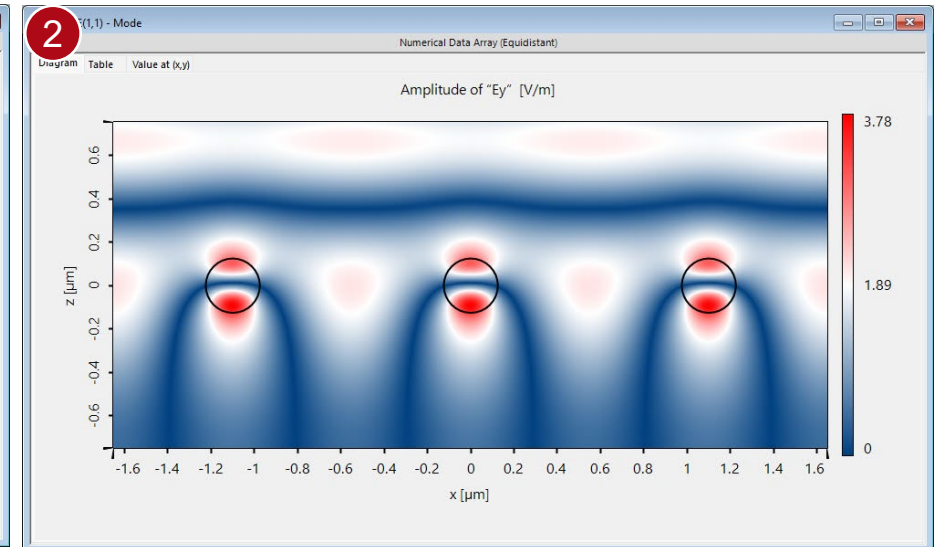
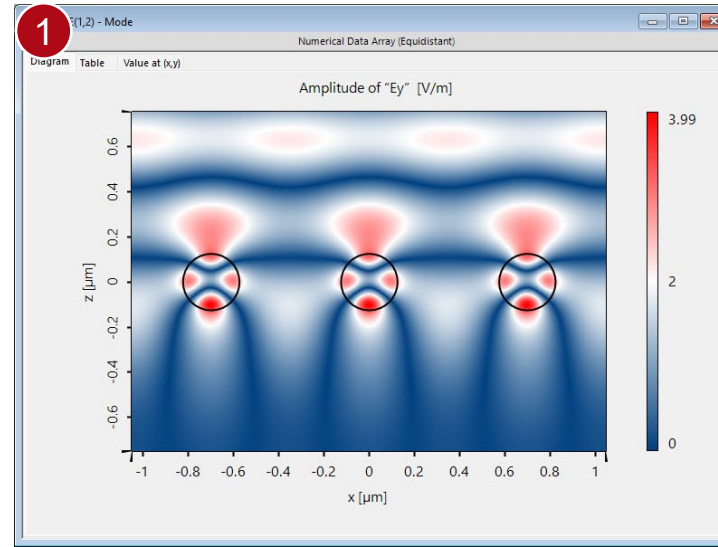
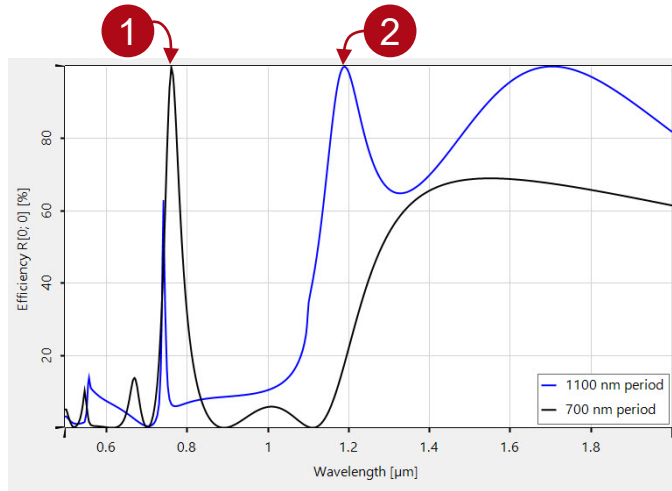


configuration b  
& c  
TE-polarized  
source,  
500 nm period &  
1100 nm period

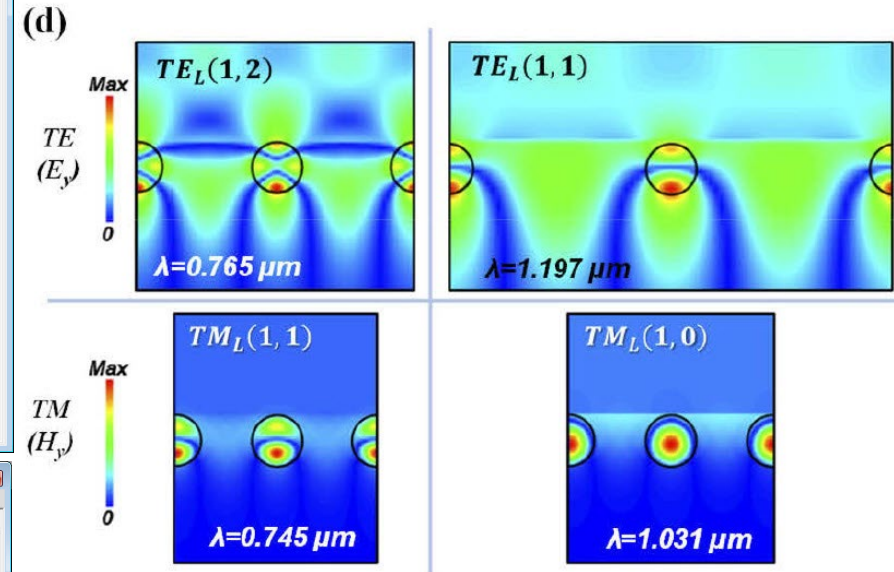
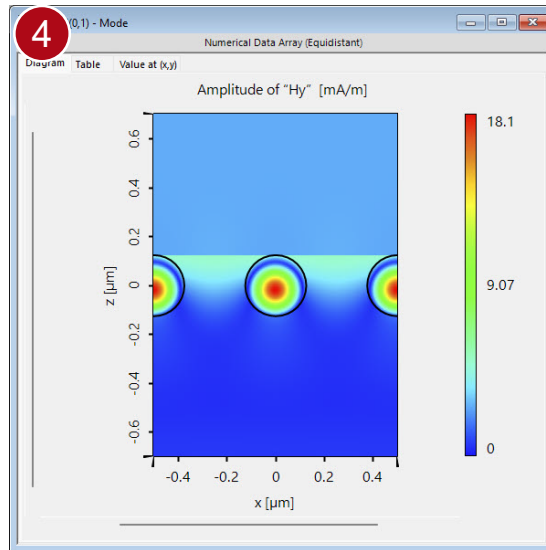
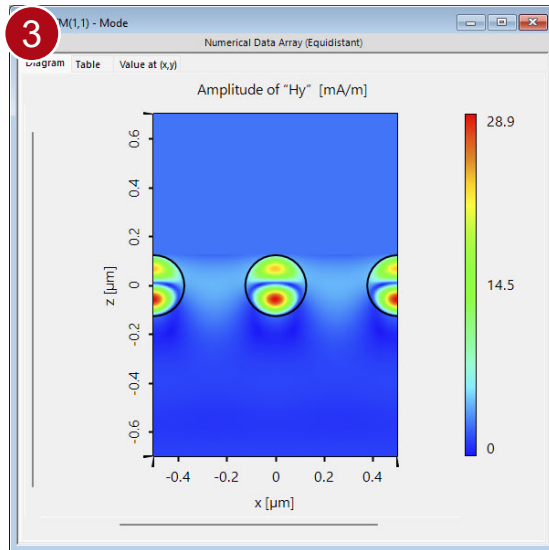
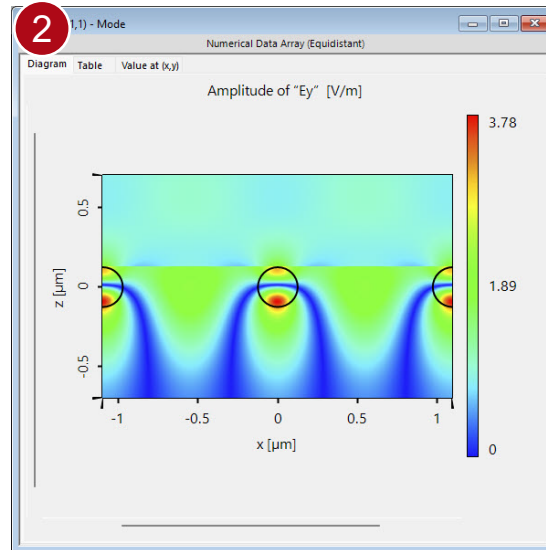
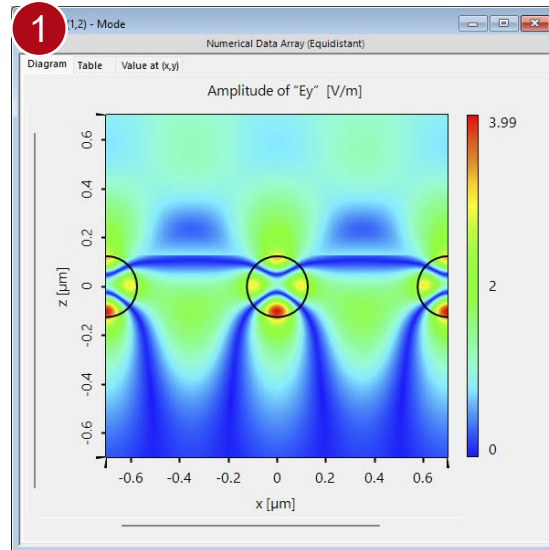
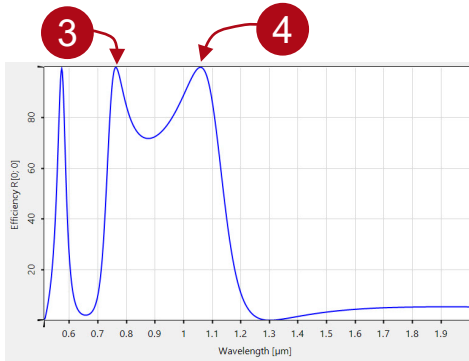
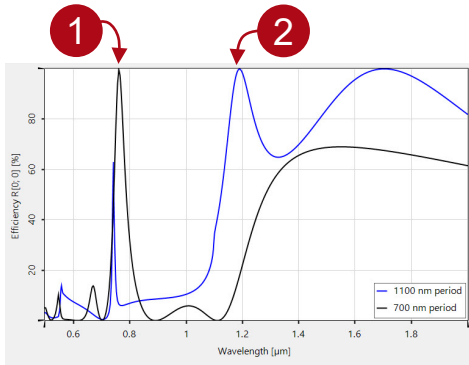


Reference: Yeong Hwan Ko, Nasrin Razmjooei, Hafez Hemmati, and Robert Magnusson, "Perfectly-reflecting guided-mode-resonant photonic lattices possessing Mie modal memory," *Opt. Express* **29**, 26971-26982 (2021)

# Task 2 – Field around the Structure



# Task 2 – Comparison with Reference

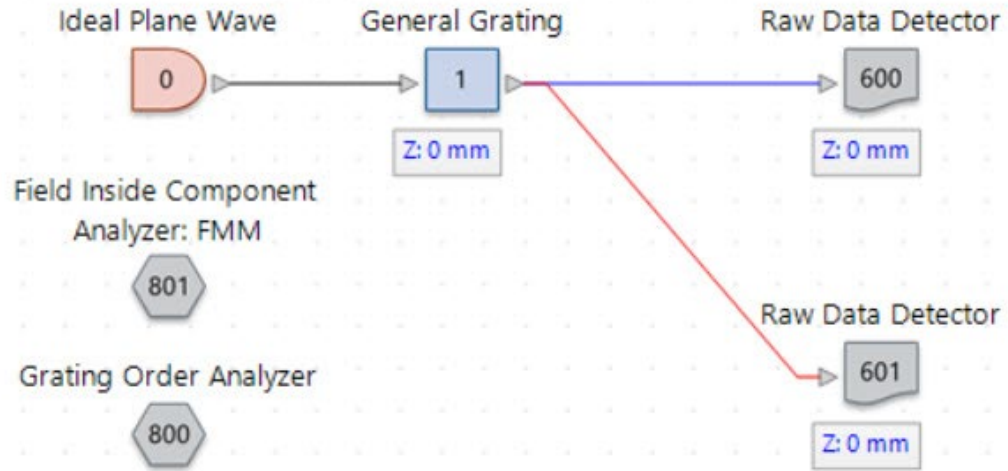


Reference: Yeong Hwan Ko, Nasrin Razmjooei, Hafez Hemmati, and Robert Magnusson, "Perfectly-reflecting guided-mode-resonant photonic lattices possessing Mie modal memory," *Opt. Express* **29**, 26971-26982 (2021)



# Workflows

# Parameter Run



To analyze the wavelength dependency of the reflectivity of the device, a parameter sweep is performed with the Parameter Run document.

More information under:

[Usage of the Parameter Run Document](#)

The screenshot shows the Parameter Specification window for a parameter run. The parameter being varied is Wavelength, ranging from 500 nm to 2 μm with 301 steps and a step size of 5 nm. The Results window shows the output of the parameter run, including a table of detector data for various iteration steps.

**Parameter Specification**

Set up the parameter(s) to be varied.

You can select one or more parameters which shall be varied as well as the resulting number of iterations. Several [modes](#) are available specifying how the parameters are varied per iteration.

Usage Mode: Standard

Filter by...

1	2	*	Object	Category	Parameter	Vary	From	To	Steps	Step Size	Original Value
			Optical Setup	Environment	System Temperature	<input type="checkbox"/>	-273.15 °C	1e+100 °C	1	1e+100 °C	20 °C
					Air Pressure	<input type="checkbox"/>	0 Pa	1 GPa	1	1 GPa	101.325 kPa
			"Ideal Plane Wave" (# 0)	Medium at "-" Output (...)	Material (Non-Dispersive Material...)	<input type="checkbox"/>	1e-300	1e+300	1	1e+300	1
					Wavelength	<input checked="" type="checkbox"/>	500 nm	2 μm	301	5 nm	1 μm
					Weight	<input type="checkbox"/>	0	1e+300	1	1e+300	1
					Polarization Angle	<input type="checkbox"/>	0°	360°	1	360°	90°

**Results**

Start the parameter run and analyze its results

Go!

Local Execution (Parallel Iterations: 8)

Use Already Calculated Results for Next Run

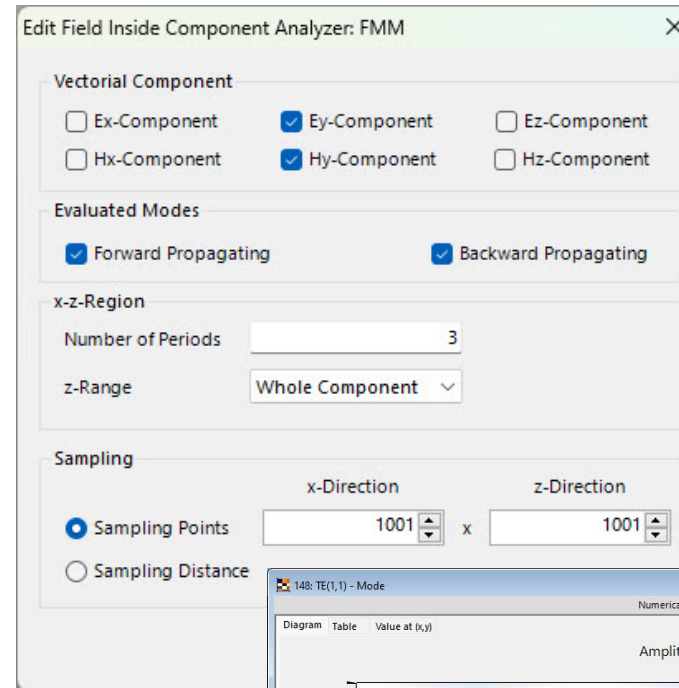
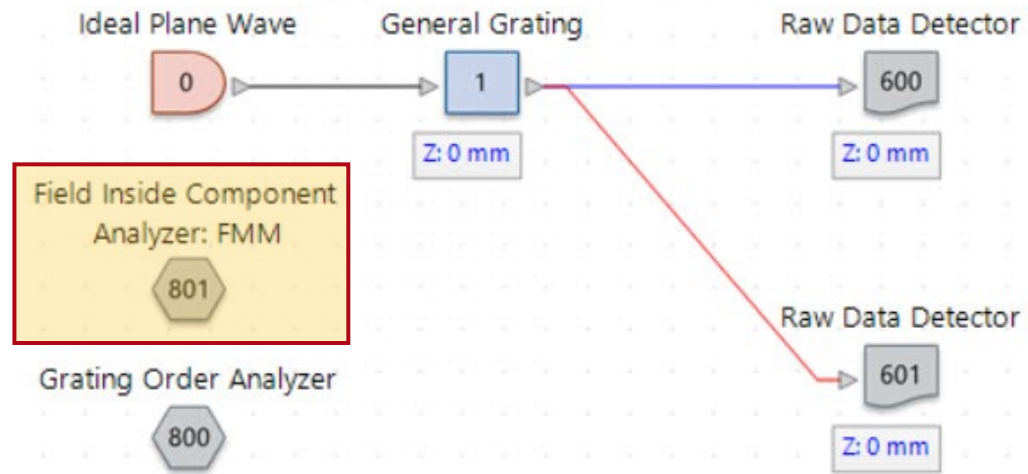
Detector	Subdetector	Combined Output	Iteration Step			
			53	54	55	56
Varied Parameters	Wavelength ("Ideal Plane	Data Array	760 nm	765 nm	770 nm	775 nm
	Efficiency T[0; 0]	Data Array	0.1364987123 %	2.927417807 %	12.17003919 %	24.07108032 %
	Spherical Angle Phi T[0; 0]	Data Array	0°	0°	0°	0°
	Spherical Angle Theta T[0; 0]	Data Array	0°	0°	0°	0°
"Grating Order Analyzer" (# 800) (Results for Individual Orders)	Efficiency R[0; 0]	Data Array	99.86350129 %	97.07258219 %	87.82996081 %	75.92891968 %
	Spherical Angle Phi R[0; 0]	Data Array	0°	0°	0°	0°
	Spherical Angle Theta R[0; 0]	Data Array	0°	0°	0°	0°

Create Output from Selection

Filter Rows by...

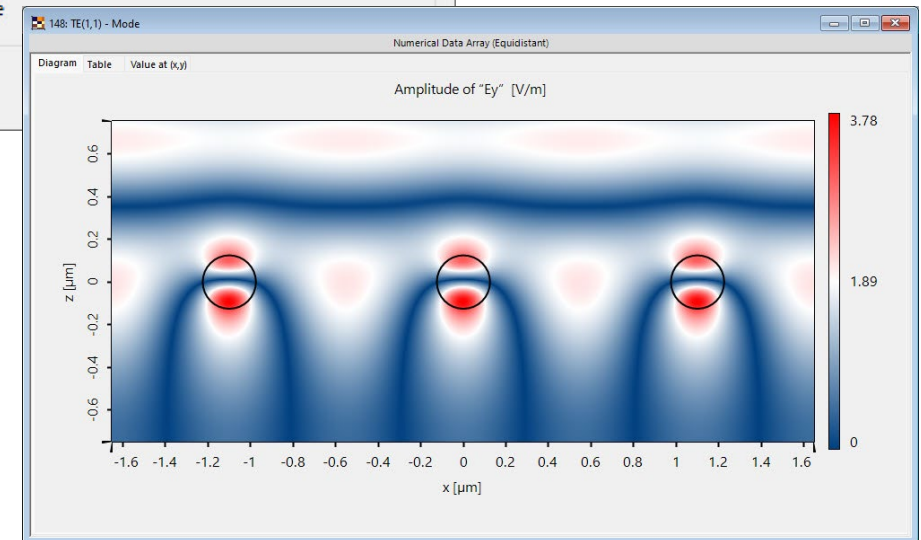
< Back Next > Show

# Field Inside Component Analyzer: FMM



With the *Field Inside Component Analyzer: FMM*, the propagated field can be displayed for the various configurations. Find more information under:

[Field Inside Component Analyzer: FMM](#)



# Post-Processing

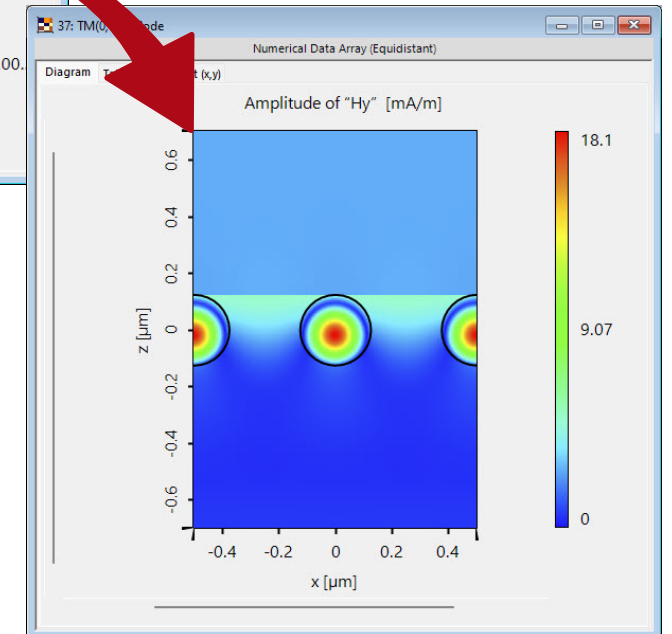
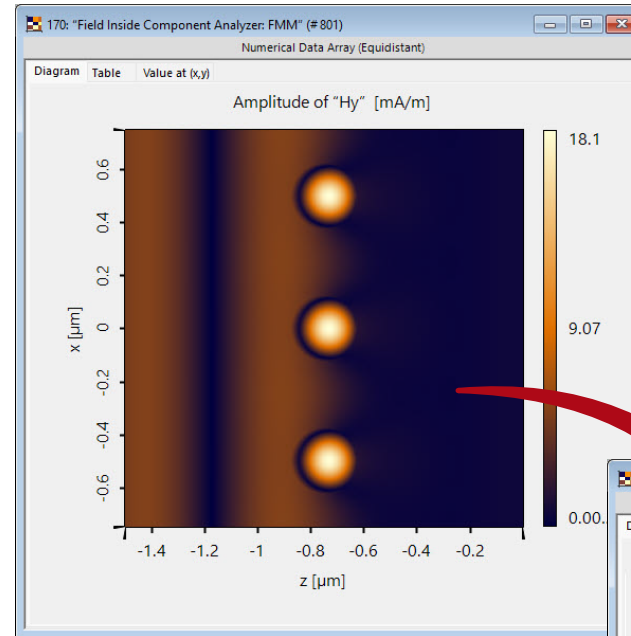
## Workflow: How to Format VLF Results

### Add Structure to Result:

- [Flexible Region Configuration](#)
- [Graphics Add-ons](#)
- [Add Region to Data Array](#)

### Change Format of Data Array:

- [General Manipulation Tools for Data Arrays](#)
- [View Settings for 2D Data Arrays](#)



# Document Information

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title	Resonant Photonic Lattices
document code	GRT.0039
document version	1.0
required packages	-
software version	2024.1 (Build 1.132)
category	Use Case
further reading	<a href="#"><u>Usage of the Parameter Run Document</u></a> <a href="#"><u>Field Inside Component Analyzer: FMM</u></a> <a href="#"><u>General Manipulation Tools for Data Arrays</u></a>