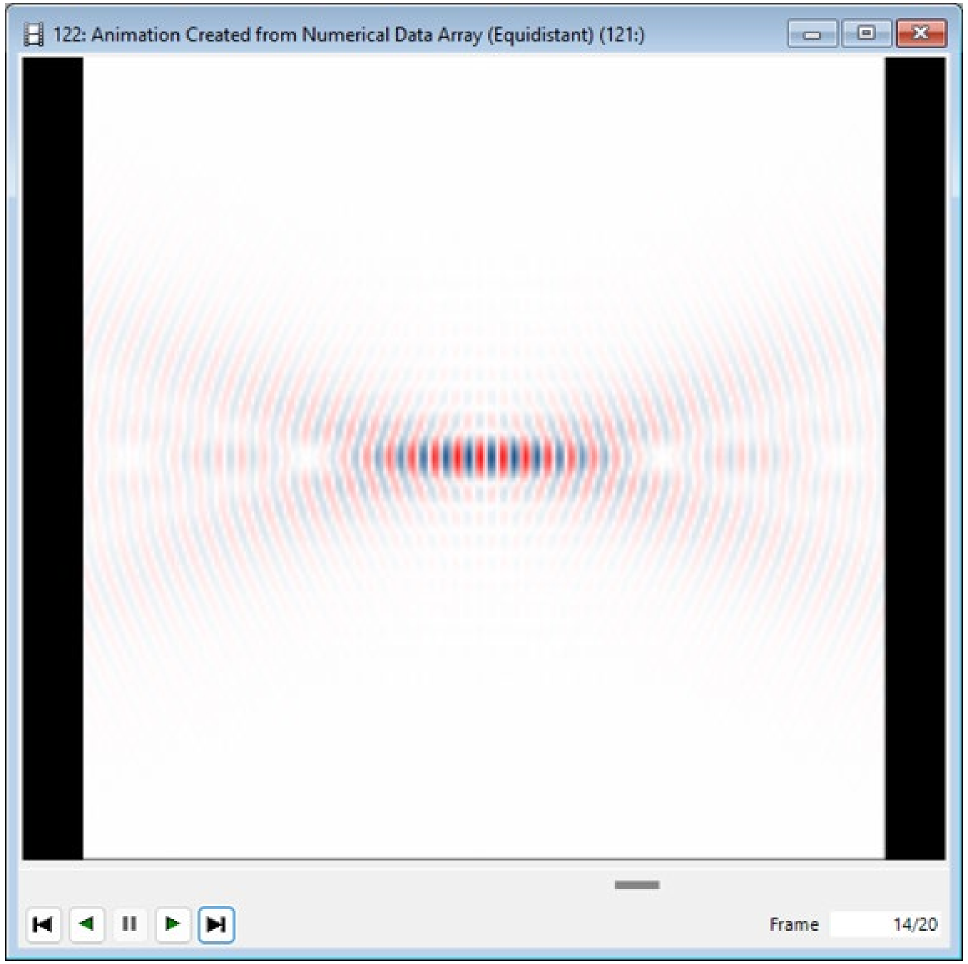
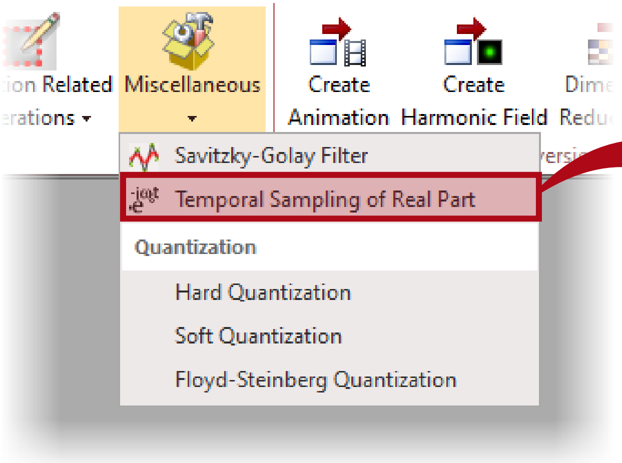
Visualize Time Dependency of a Propagating Field

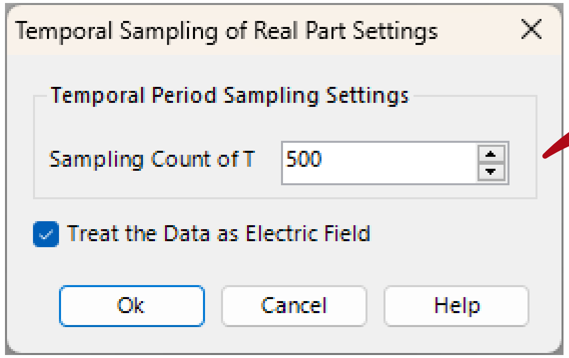
Abstract

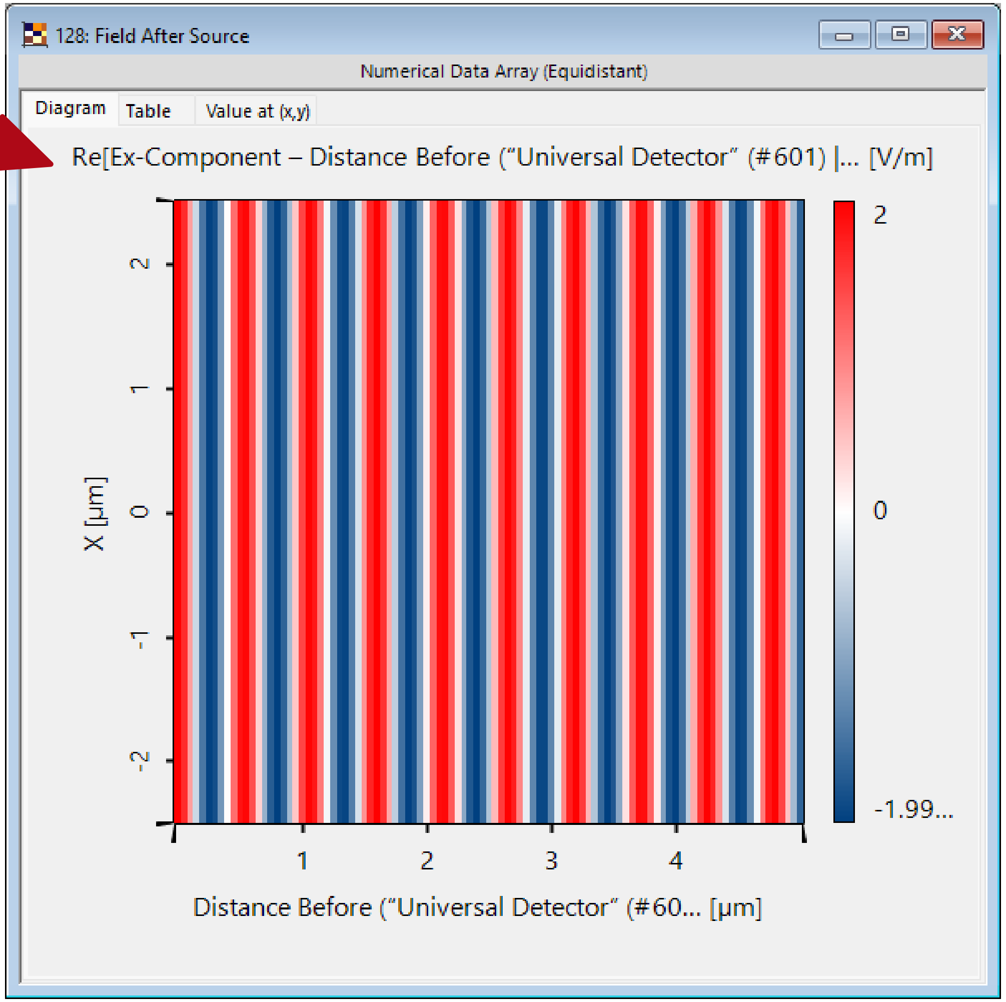


While complex fields and amplitudes are commonly used to represent electromagnetic fields, the actual field propagates along time. This tutorial explores methods for visualizing real-time field propagation in VirtualLab Fusion, demonstrating the concept through two distinct examples.

Temporal Sampling of Real Part



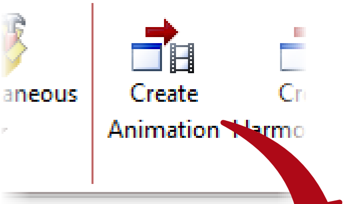


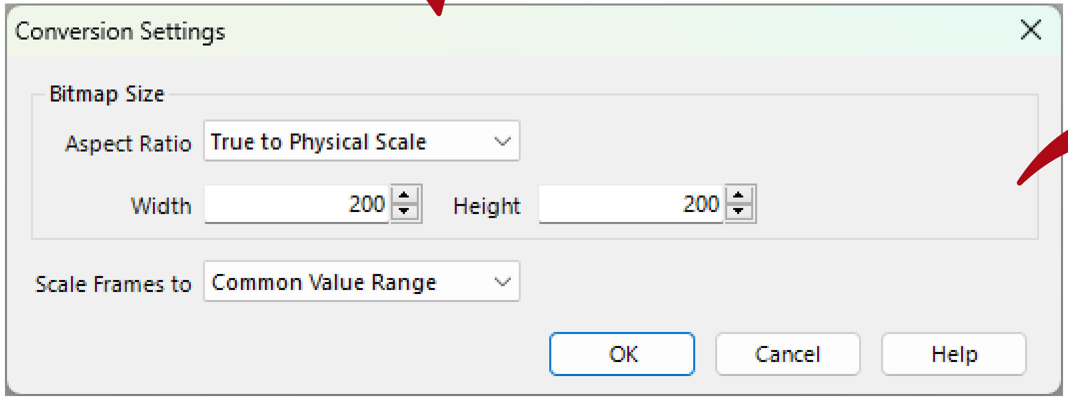


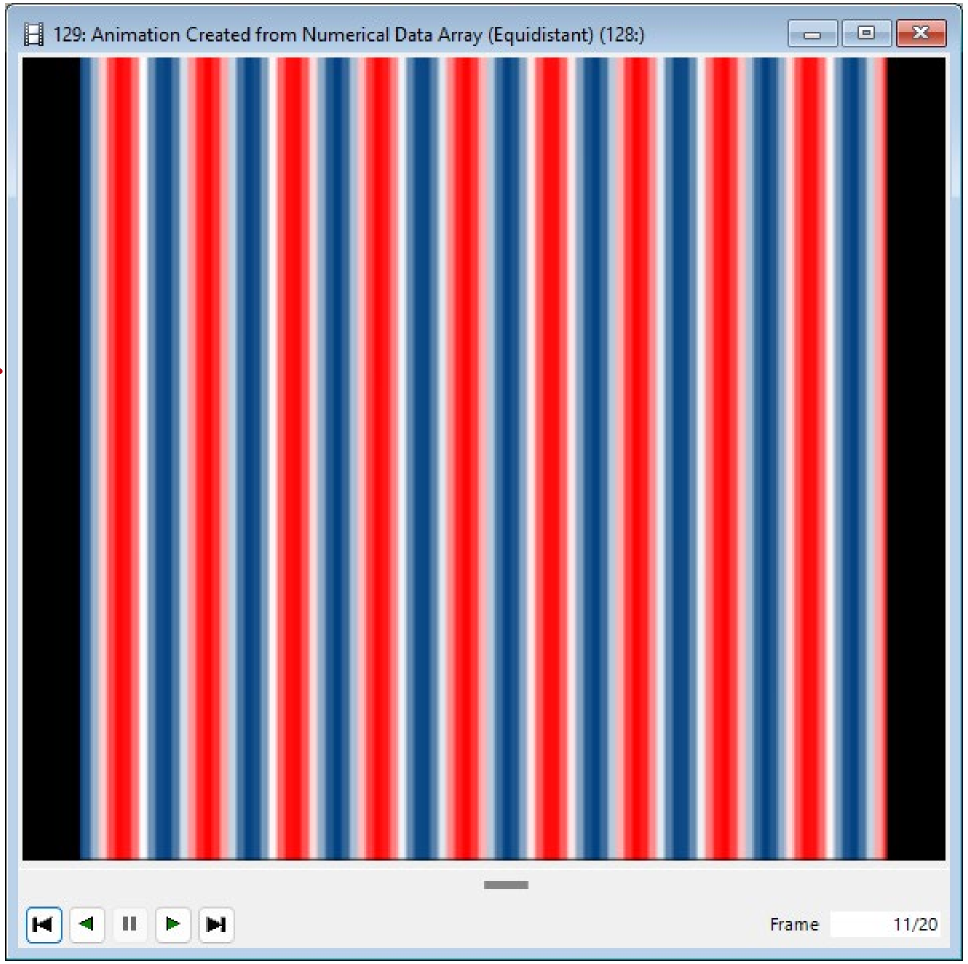
2D *Harmonic Fields* with a single subset can have a time dependency added by the *Temporal Sampling of Real Part* functionality under *Manipulations/Miscellaneous*. This function will multiply $e^{i\omega_0 t}$ onto the data array, with ω_0 calculated from the temporal period via $T = 2\pi/\omega_0$ and then extract the real part at $t = \frac{1}{n}T, \frac{2}{n}T, \ldots, T$ with n being the parameter defined by *Sampling Count of T*.

If the *Treat the Data as Electric Field* flag is active it additionally multiply the extracted real part by 2.

Create Animation







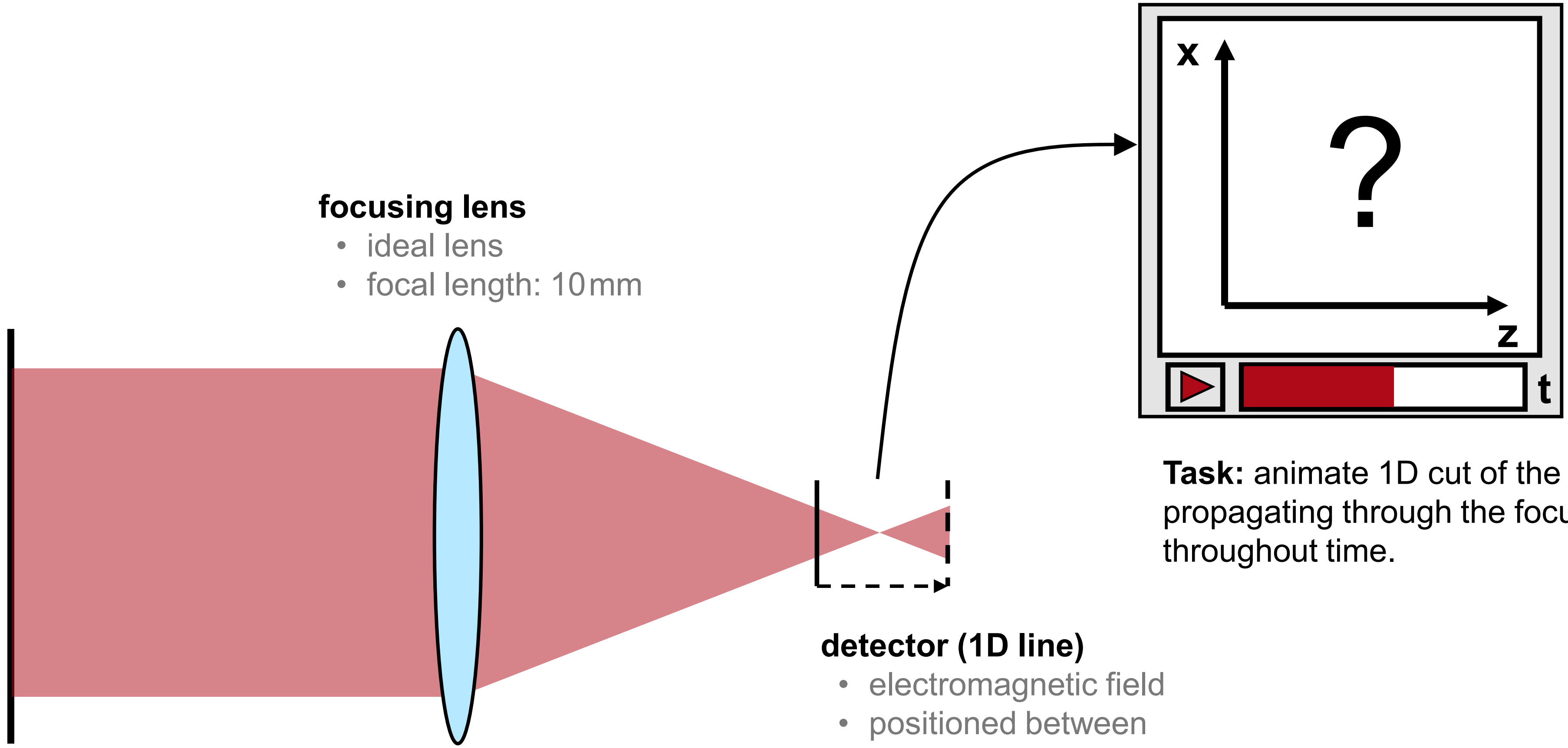
The new document can then by turned into a movie by the *Create Animation* button in *Manipulations*.
More information about animation generation under:
Overview Image

Example 1 – Propagation of an Inclined Plane Wave over a Distance of 10 mm

Modeling Scenario

source
- plane wave
- wavelength: 532 nm
- linearly polarized in x
- diameter: 10 mm

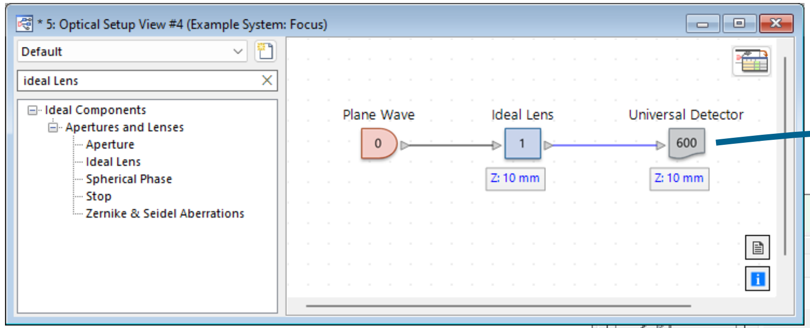
focusing lens
- ideal lens
- focal length: 10 mm



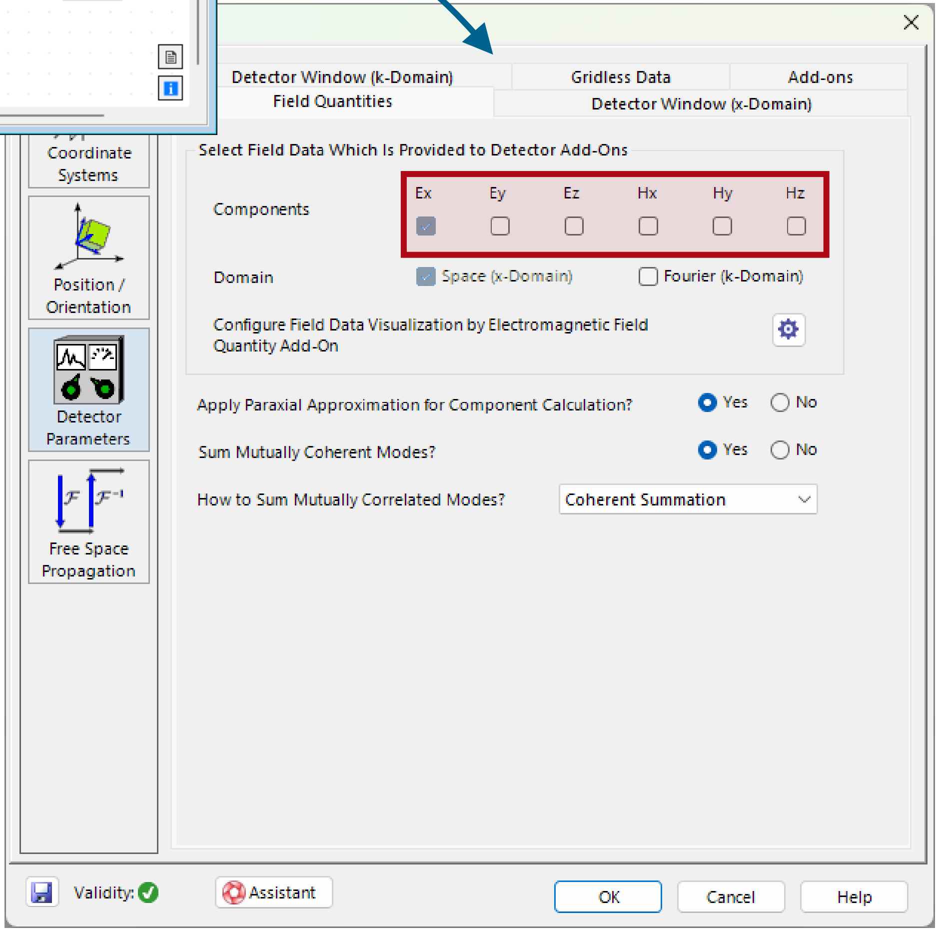
detector (1D line)
- electromagnetic field
- positioned between 9.99 mm and 10.01 mm after lens

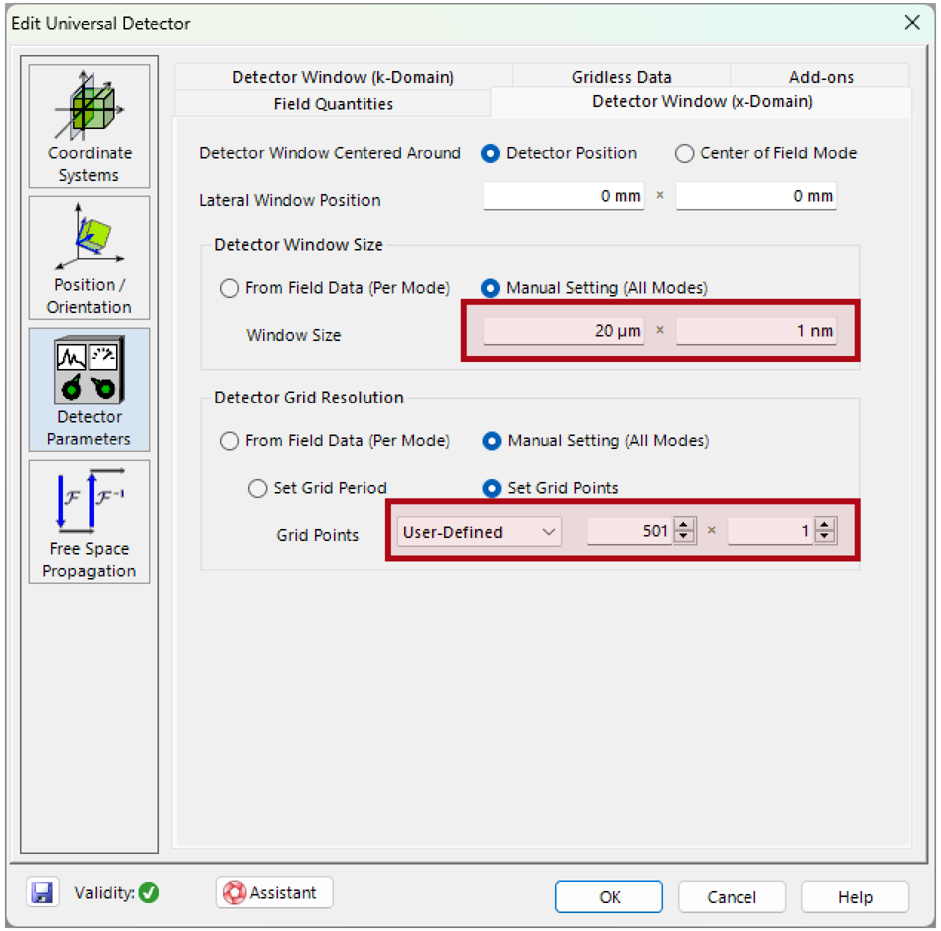
Task: animate 1D cut of the field propagating through the focus throughout time.

Set up Optical System



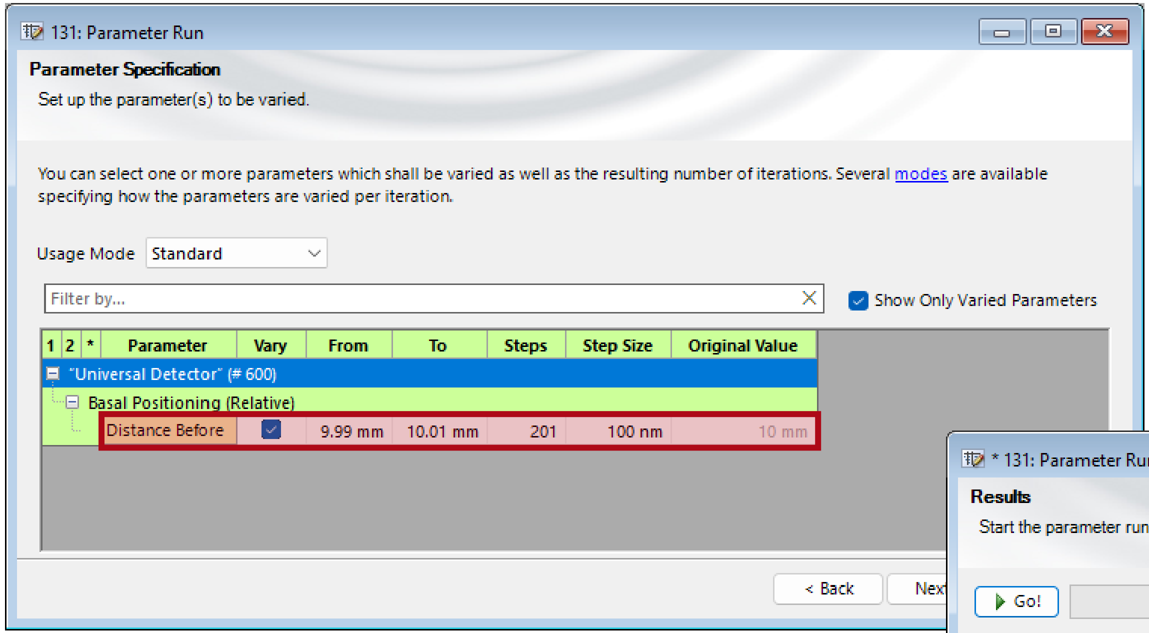
Set up the detector so that it only detects a single component and is one dimensional. Ensure sufficient sampling points to avoid Moiré effects.

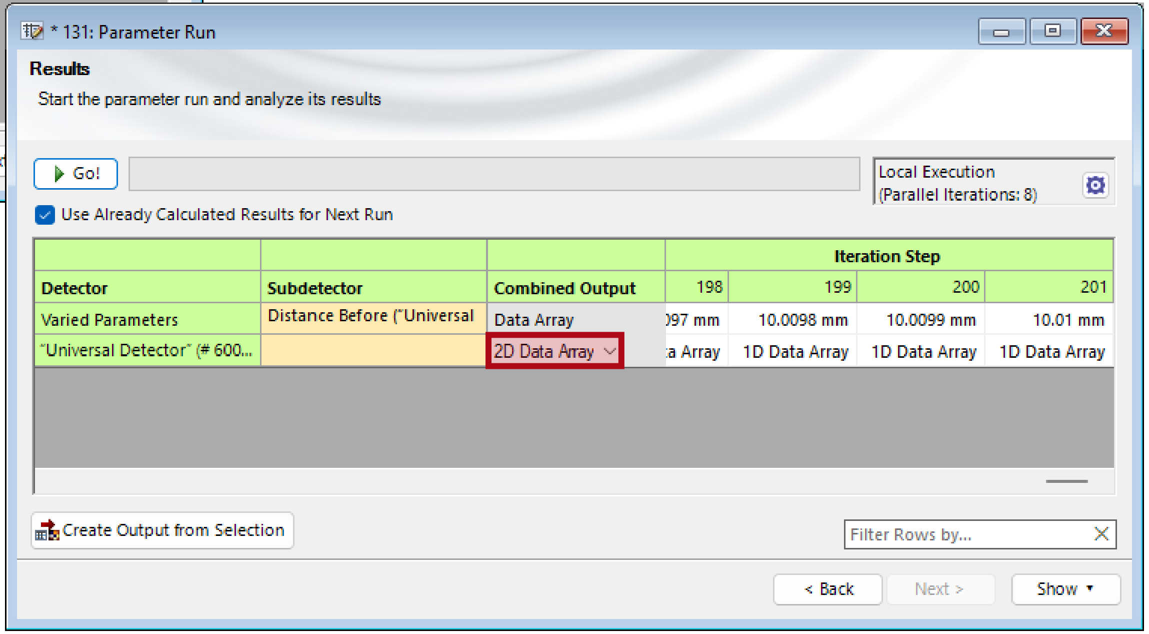




Perform a Parameter Run

Perform a *Parameter Run*, varying the *Distance Before* parameter from the detector between 9.99 mm and 10.01 mm. Ensure sufficient sampling points in z-direction through the *Steps* column.

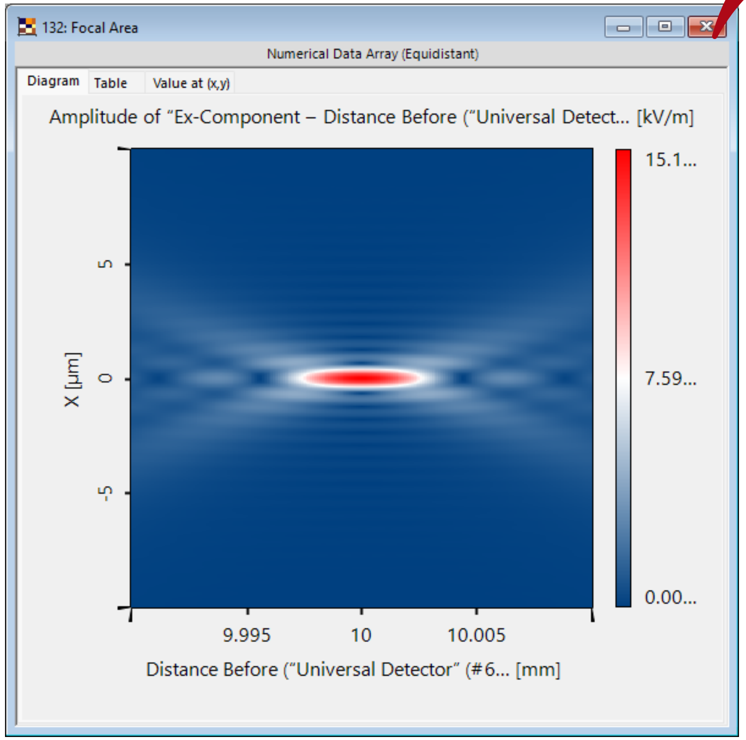


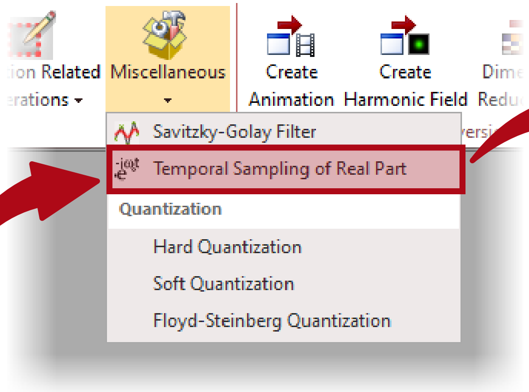


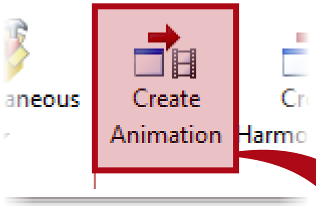
Extract the output by double-clicking the *Universal Detector* – row. Ensure that the *Combined Output* is set to *2D Data Array*.

Temporal Sampling & Movie Generation

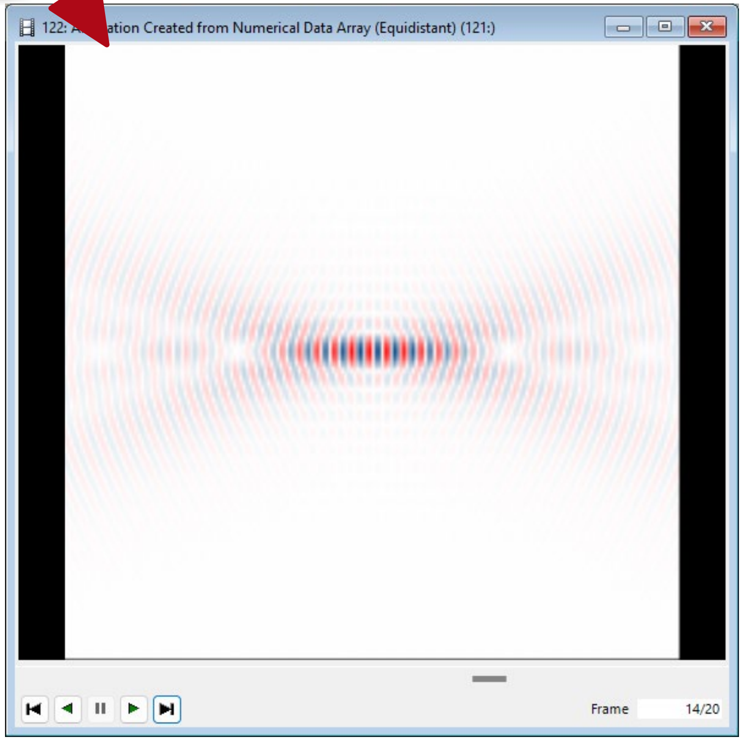
result of the *Parameter Run*







generated movie



Follow the workflow demonstrated on pages 3 and 4 to create a movie of the time dependent propagation of the field through the focal area.

Example 2 – Field Inside Photonic Lattices

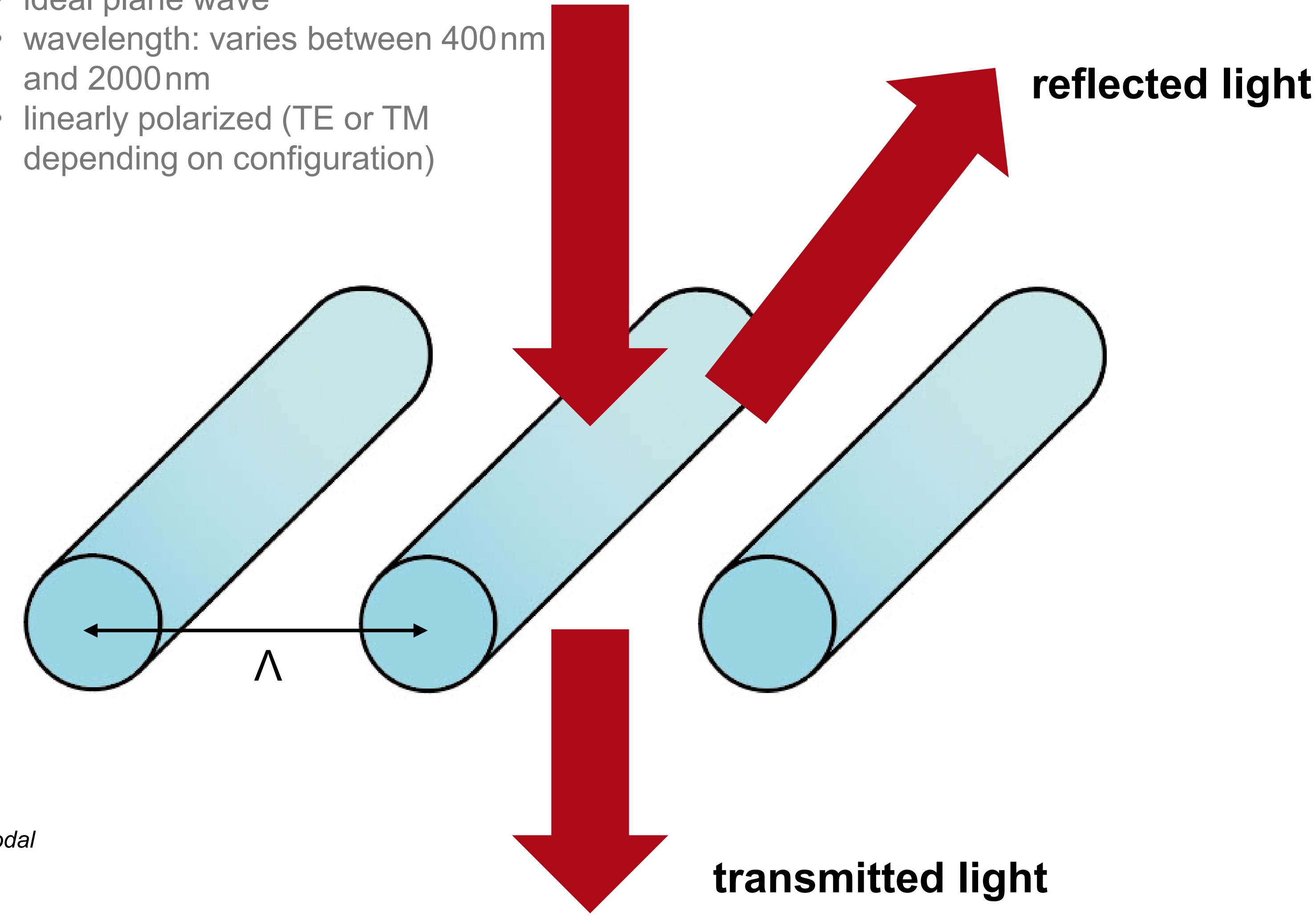
Modeling Scenario

source

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

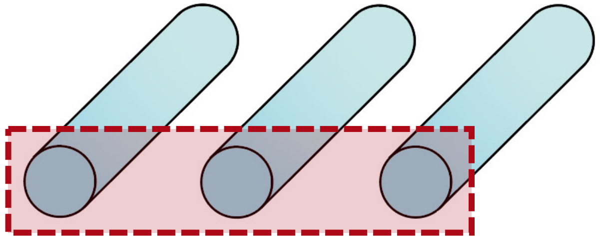
photonic lattices

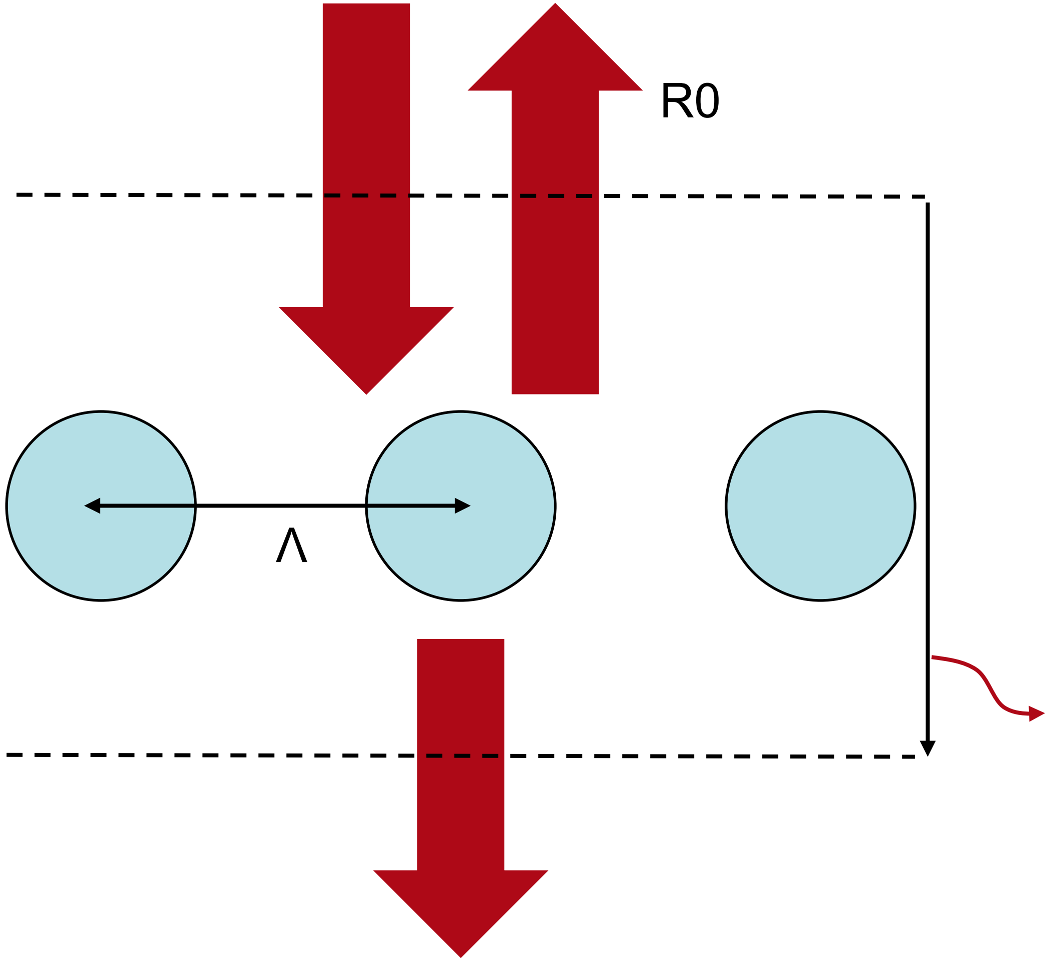
- 1D lamellar grating
- invariant in y-direction
- refractive index of cylinders: 3.5
- 3 configurations with different period Λ: 500 nm, 700 nm and 1100 nm



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)*

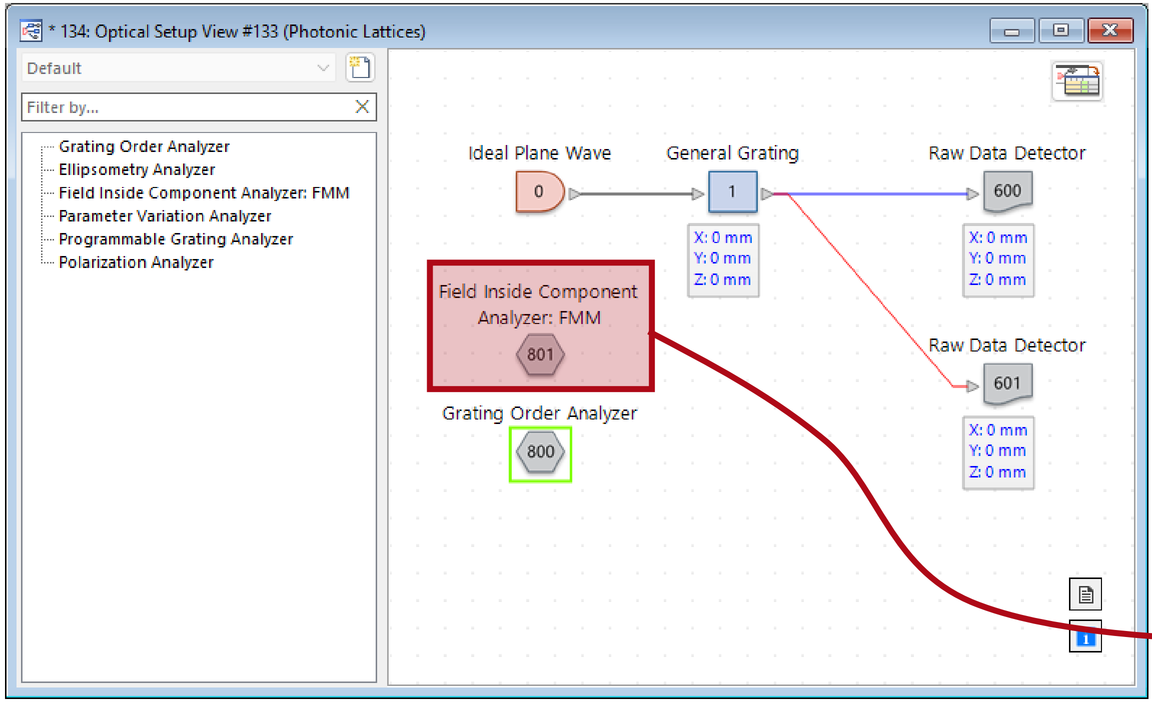
Scenario

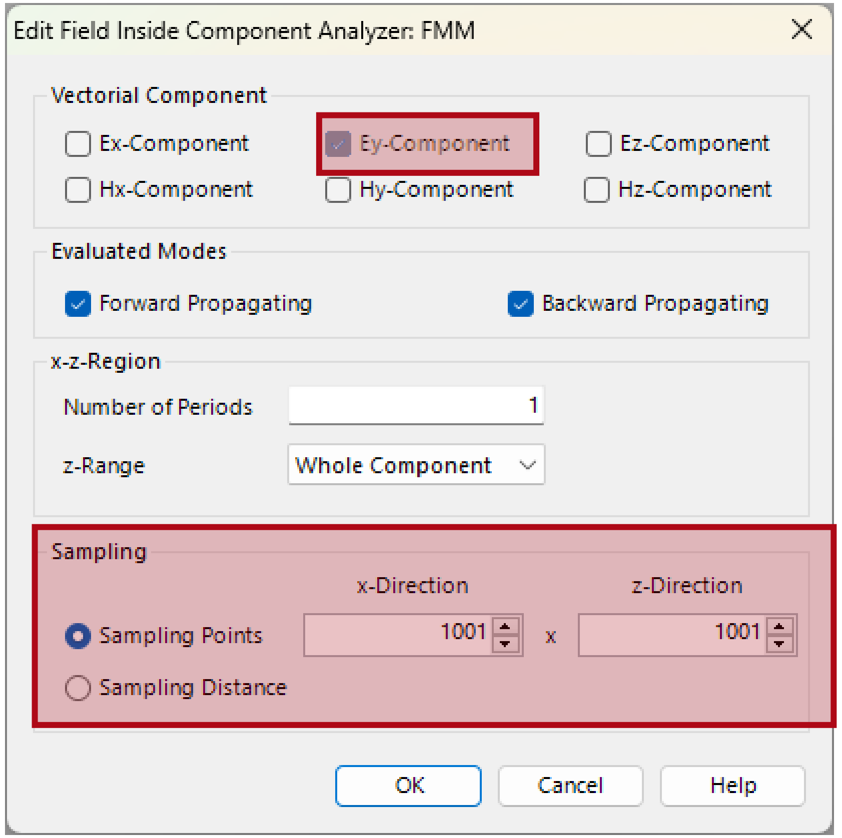




Task: detection of the field in the vicinity around the cylinders at wavelengths that provide high reflectivity.

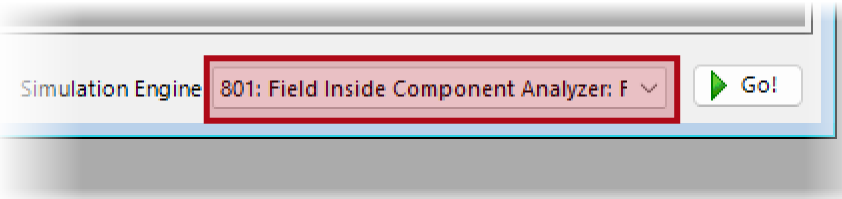
Field Inside Analyzer: FMM





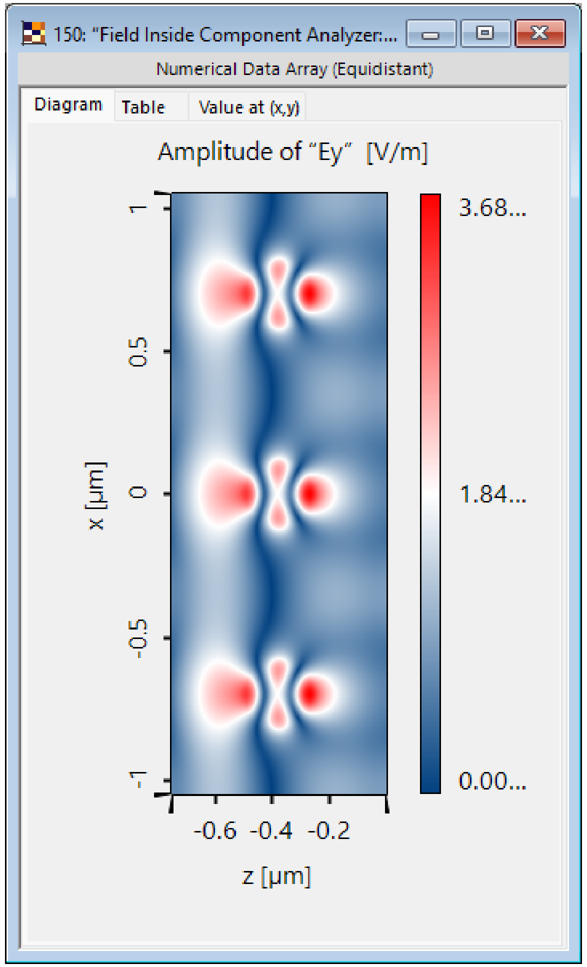
The sample files for this task can be found in the following use case:
[Resonant Photonic Lattices]

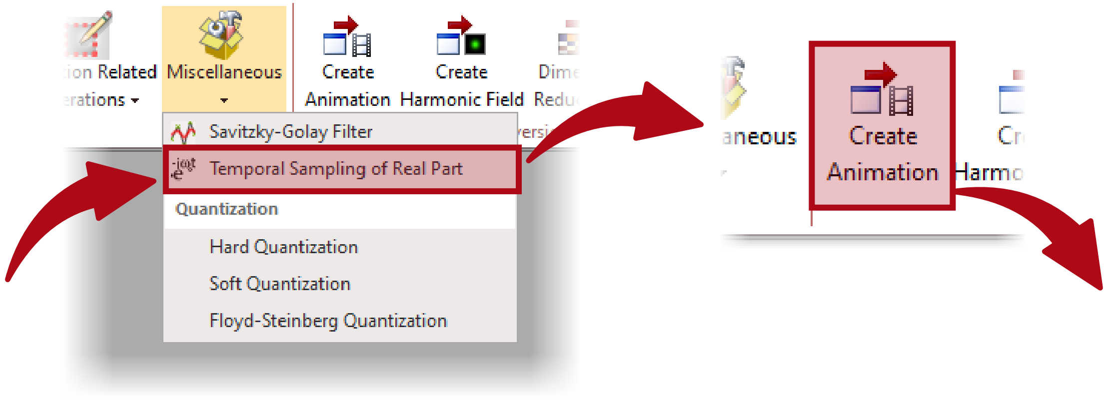
For our demonstration we want to setup the *Field Inside Component Analyzer: FMM* in a way that it only detects one component and that efficient sampling is ensured. Then we simulate the system using the analyzer as *Simulation Engine*.



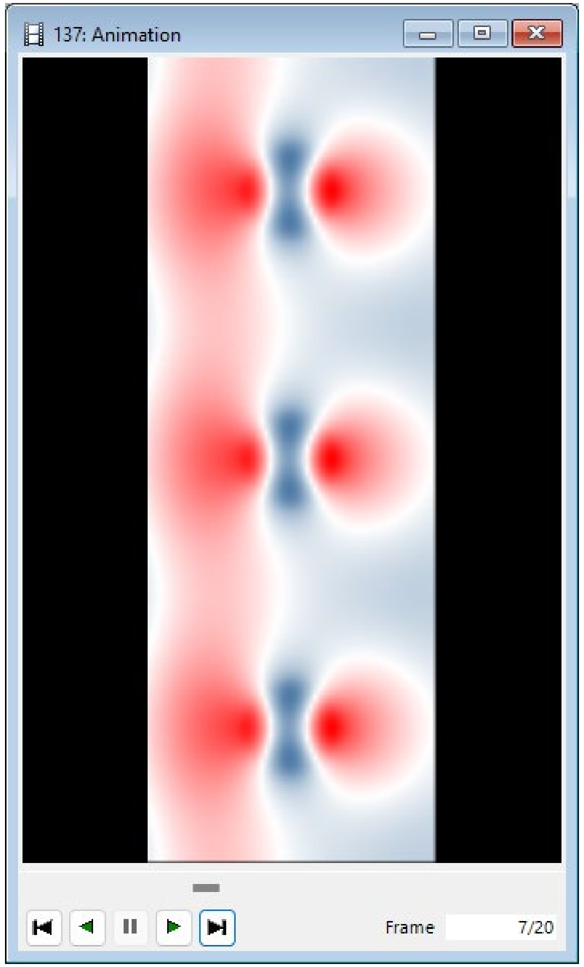
Temporal Sampling & Movie Generation

result of the *Field Inside Analyzer: FMM*





generated movie



Follow the workflow demonstrated on page 3 and 4 to create a movie of the time dependant propagation of the field through the focal area.

Document Information

title	Visualize Time Dependency of a Propagating Field
document code	TUT.0437
document version	1.0
required packages	-
software version	2024.1 (Build 2.74)
category	Tutorial
further reading	- Overview Image - Resonant Photonic Lattices

Marketing Picture