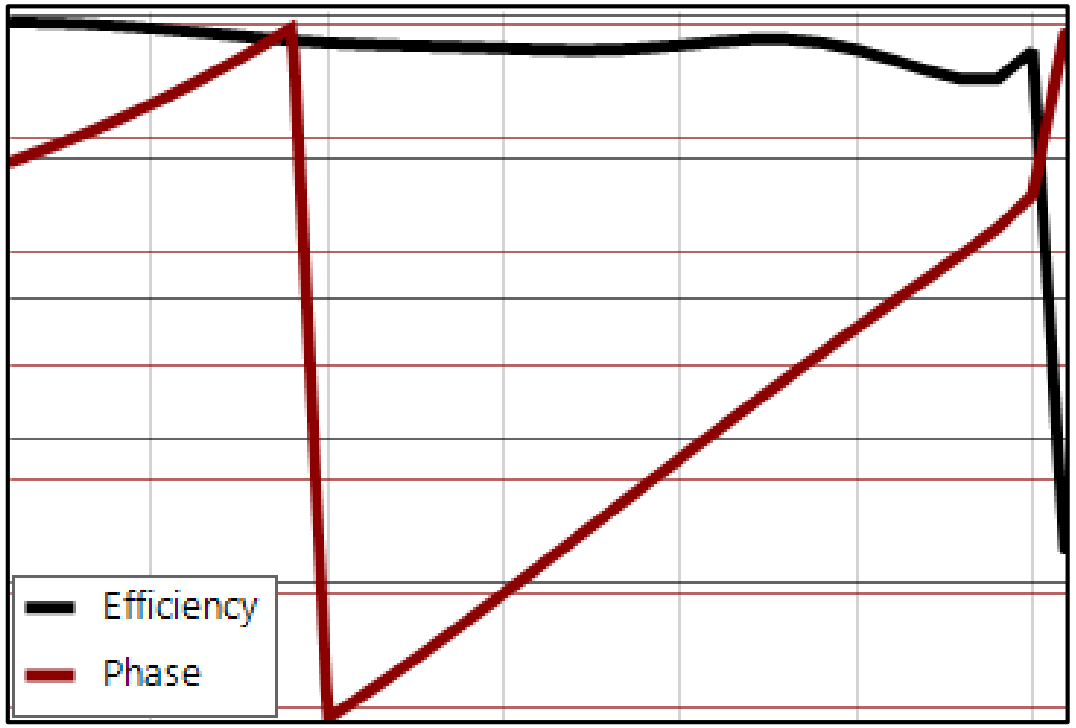
LIGHTTRANS

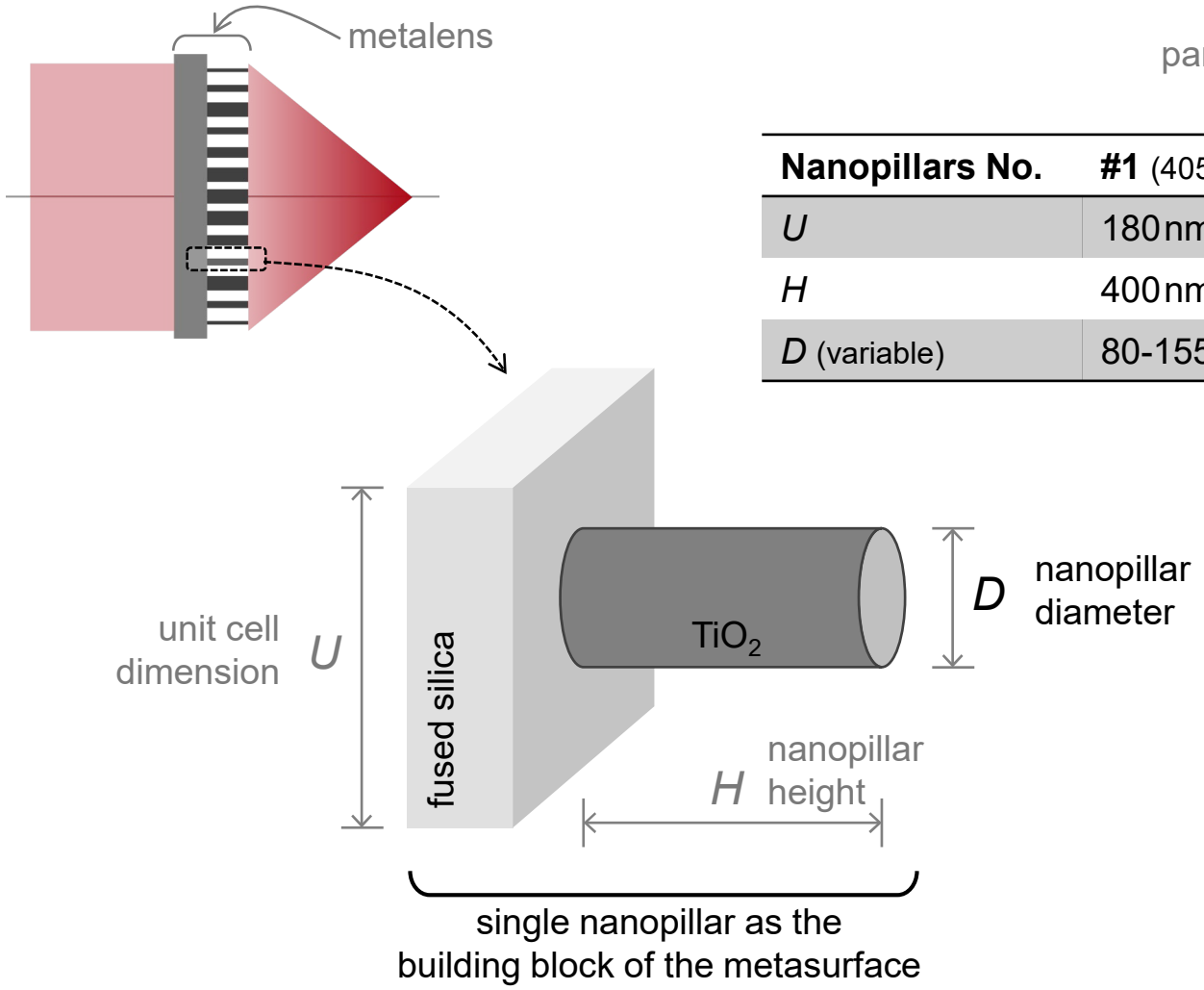
Rigorous Analysis of Nanopillar Metasurface Building Block

Abstract



With advanced fabrication techniques, people have demonstrated metalenses for visible wavelengths with high numerical apertures. A metalens is usually constructed with spatially varying nanostructures as its building blocks. In this example, we analyze the nanopillar structure which is used to compose polarization-insensitive metalenses. With the Fourier modal method (FMM, also known as RCWA), the amplitude and phase transmission of such nanopillars are calculated rigorously.

Modeling Task



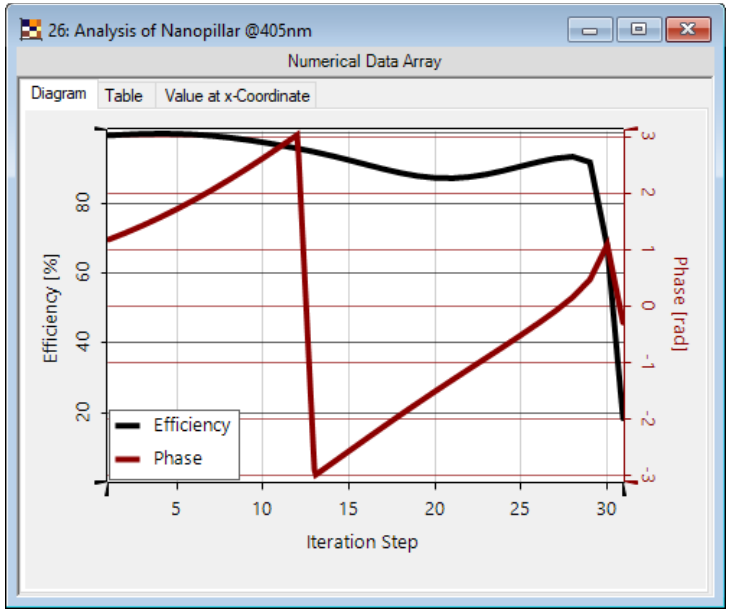
parameters from M. Khorasaninejad, *Nano Lett*. 2016, 16, 7229-7234

Nanopillars No.	**#1** (405nm)	**#2** (532nm)	**#3** (660nm)
U	180nm	250nm	350nm
H	400nm	600nm	600nm
D (variable)	80-155nm	100-220nm	100-320nm

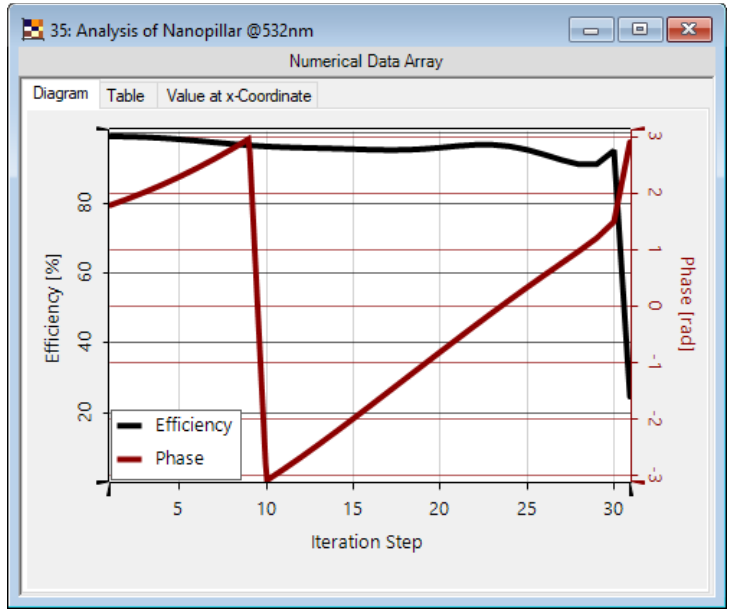
By varying the nanopillar diameter, the metasurface building block is supposed to have phase modulation covering 2π. How to evaluate such nanopillar structure rigorously?

Nanopillar Analysis vs. Pillar Diameter

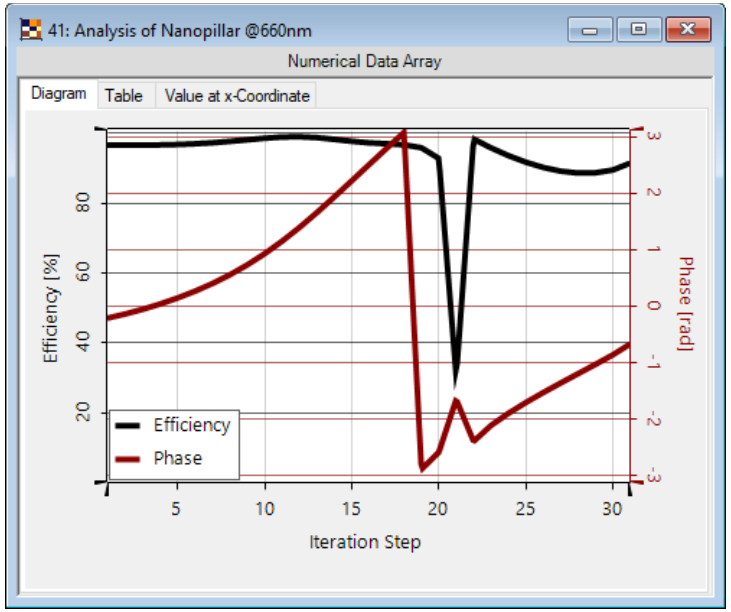
nanopillar #1



nanopillar #2



nanopillar #3



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Nanopillar Analysis vs. Pillar Diameter

- The phase modulation covers 2π range, and it changes almost linearly with pillar diameter, which enables convenient phase control.
- The transmission efficiency remains above 90% for varying pillar diameter over the design range.

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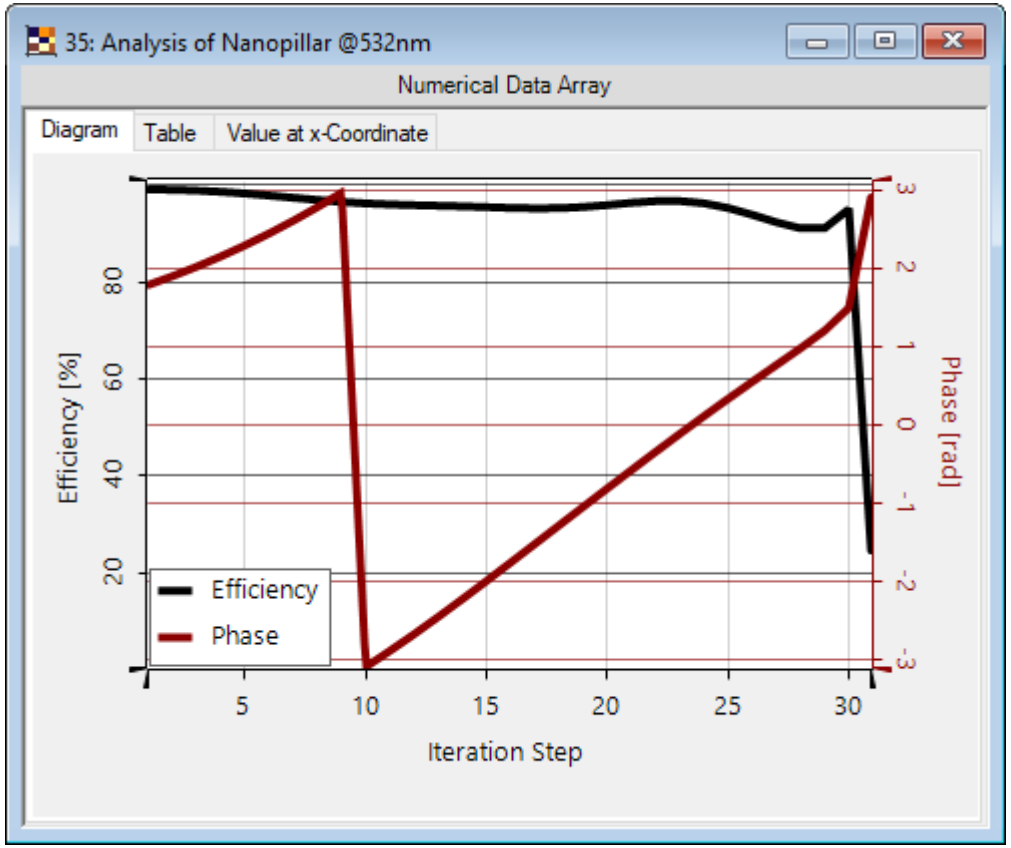
nanopillar #2



Appendix: Refractive Index of TiO_2

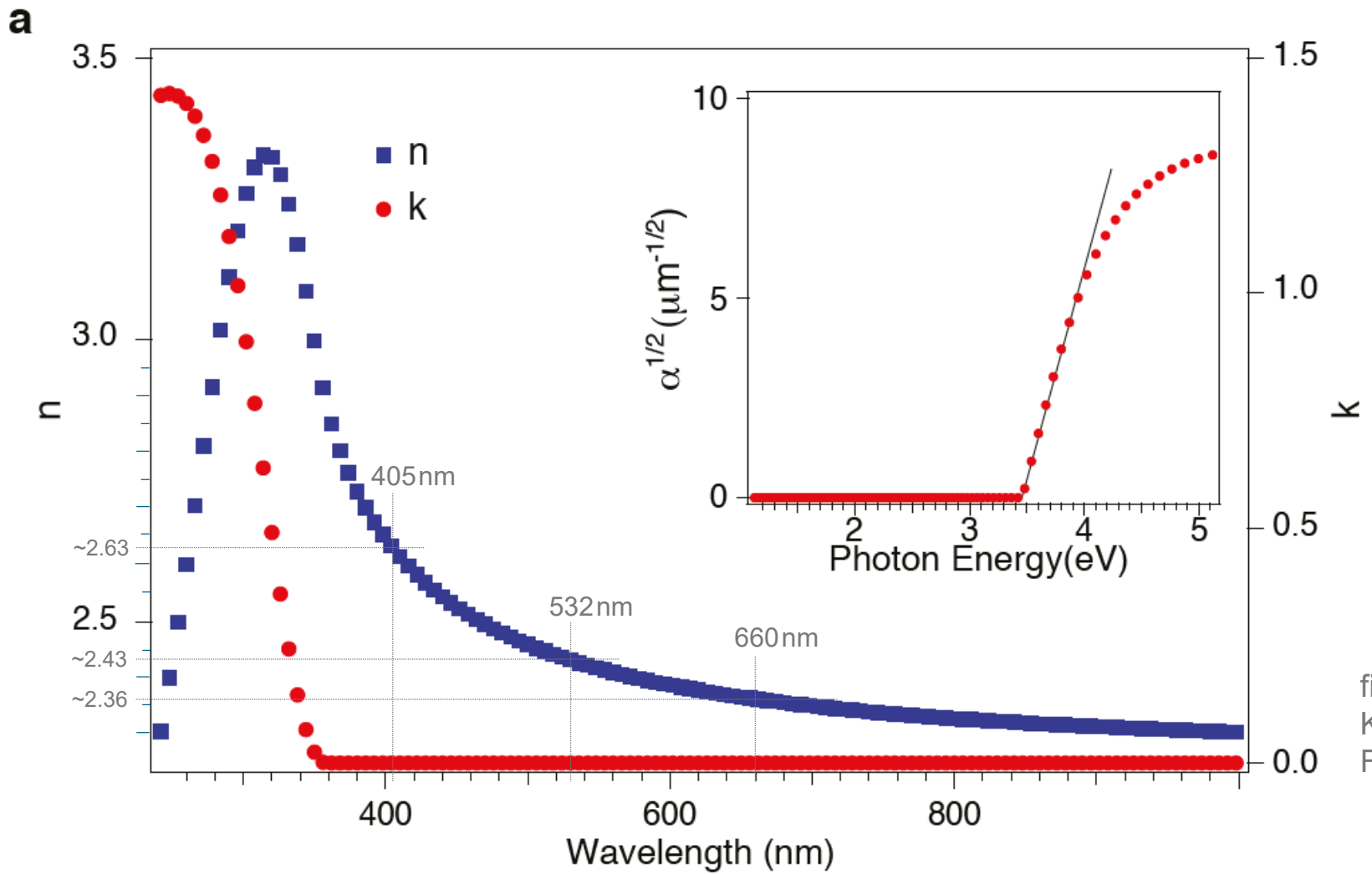
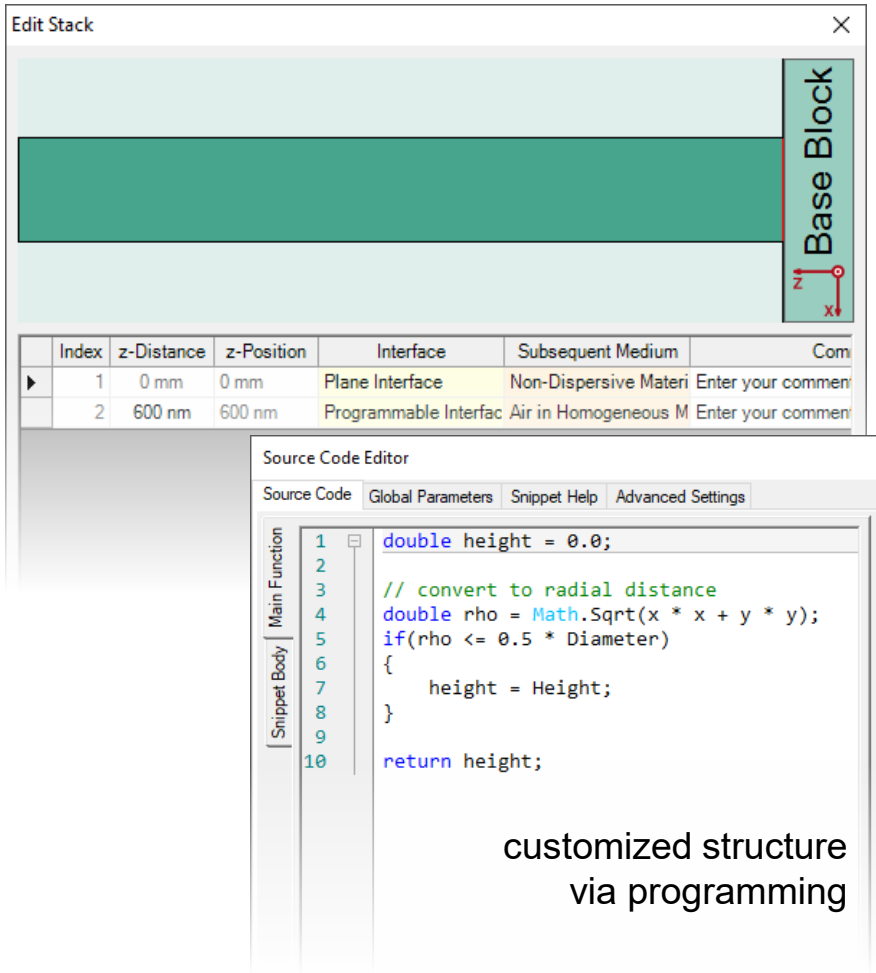


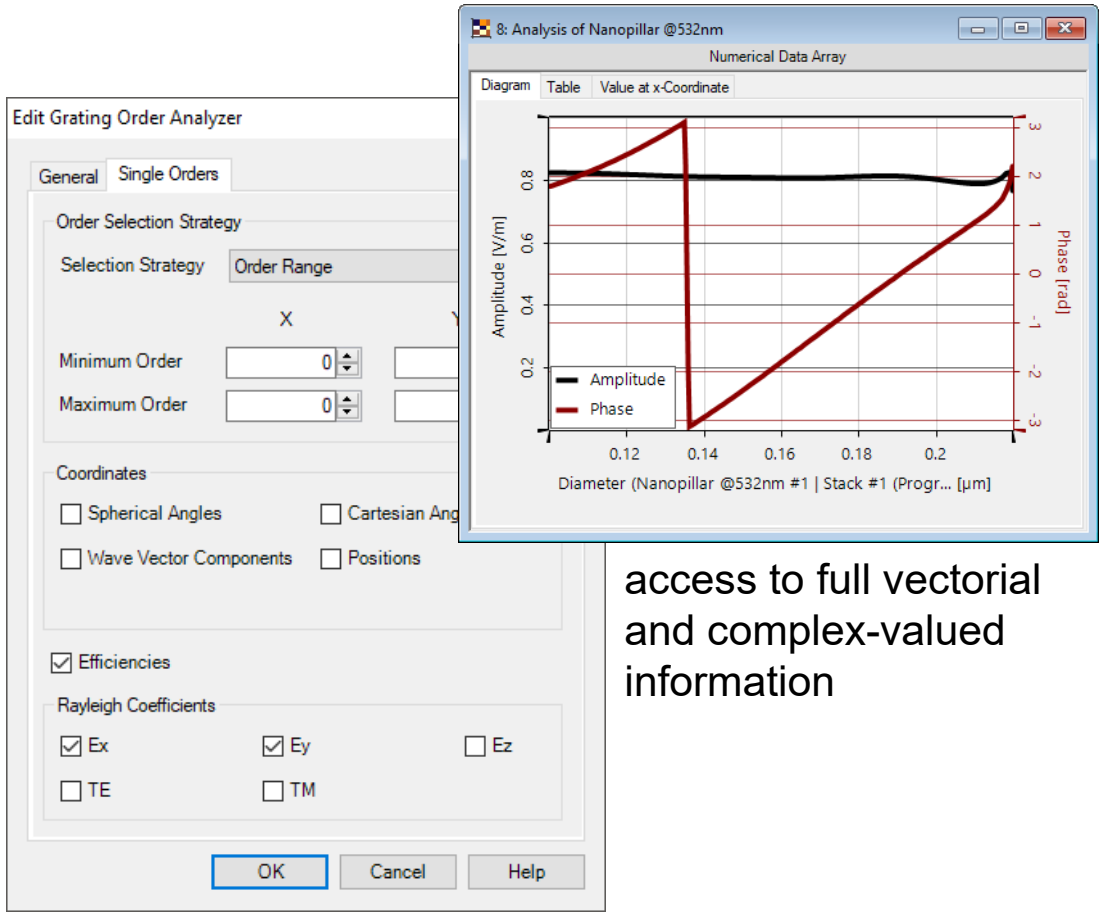
figure from R. C. Devlin, M. Khorasaninejad, W.-T. Chen, J. Oh, F. Capasso, arXiv:1603.02735 (2016)

Peek into VirtualLab Fusion

flexible pillar structure definition



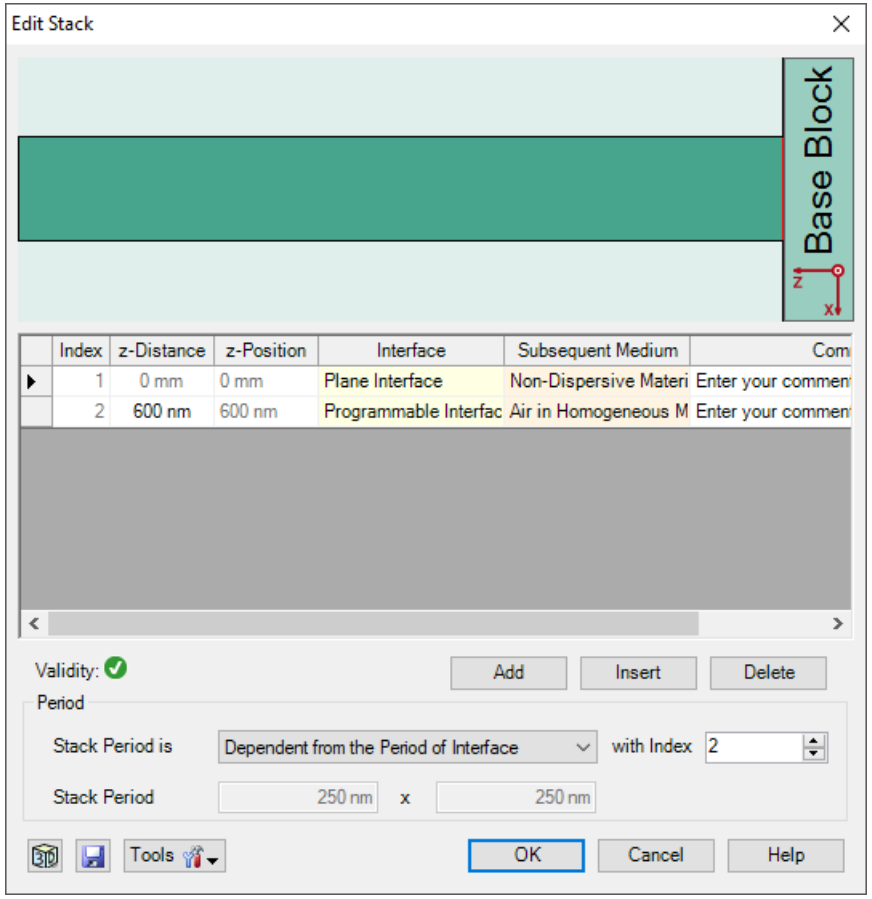
customized structure via programming



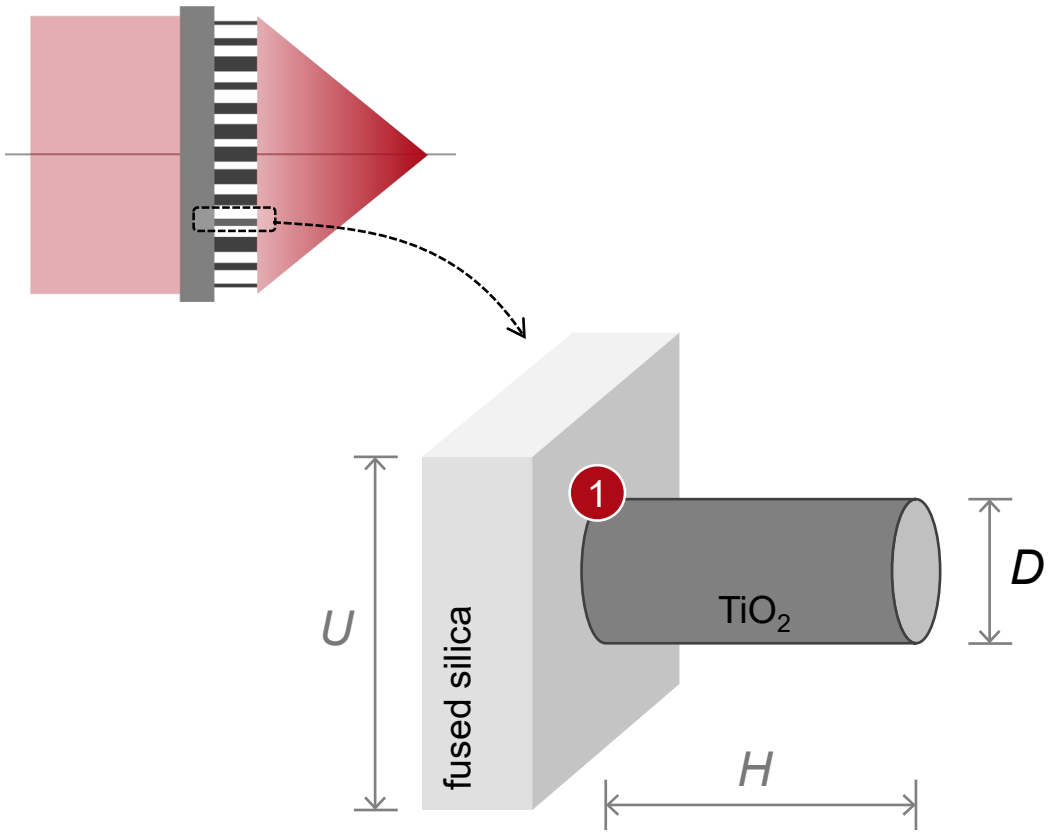
access to full vectorial and complex-valued information

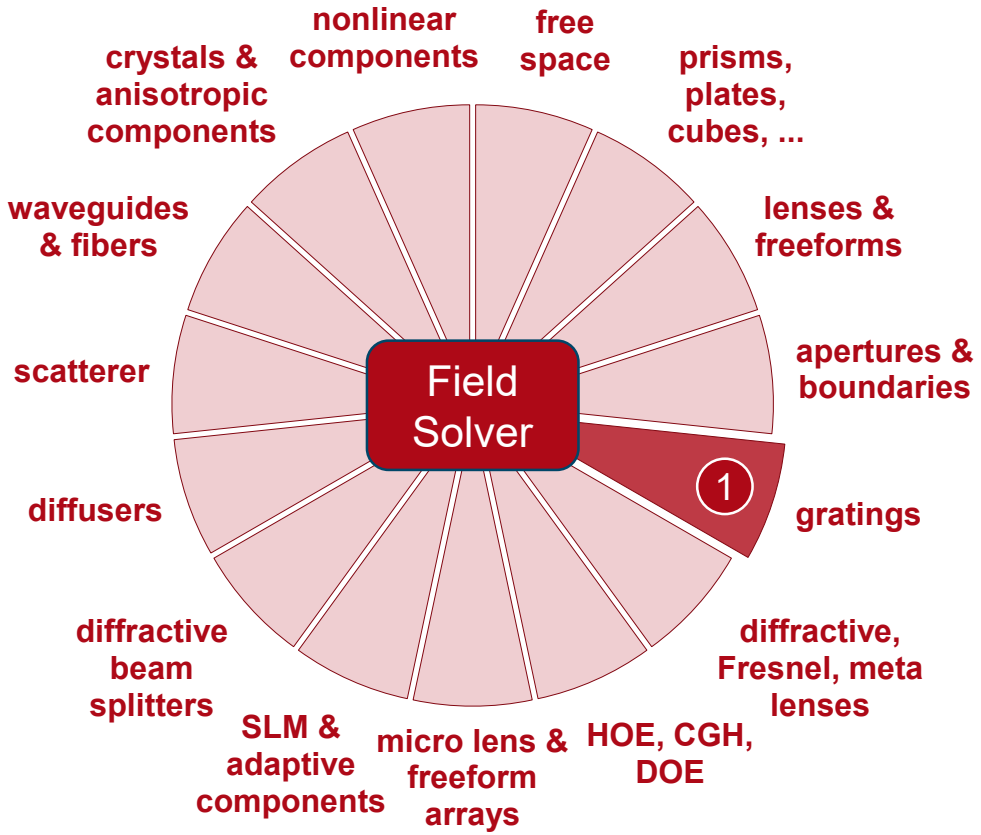
Workflow in VirtualLab Fusion

- Construct grating structure
  - Configuration of Grating Structures by Using Interfaces [Use Case]
  - Configuration of Grating Structures by Using Special Media [Use Case]
- Analyze grating diffraction efficiency
  - Grating Order Analyzer [Use Case]
- Check influence from specific parameters with Parameter Run
  - Usage of the Parameter Run Document [Use Case]



VirtualLab Fusion Technologies





Document Information

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VL version used for simulations	7.4.0.49
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further reading	- Ultra-Sparse Dielectric Nano-Wire Grid Polarizers - Investigation of Polarization State of Diffraction Orders - Rigorous Analysis and Design of Anti-Reflective Moth-Eye Structures