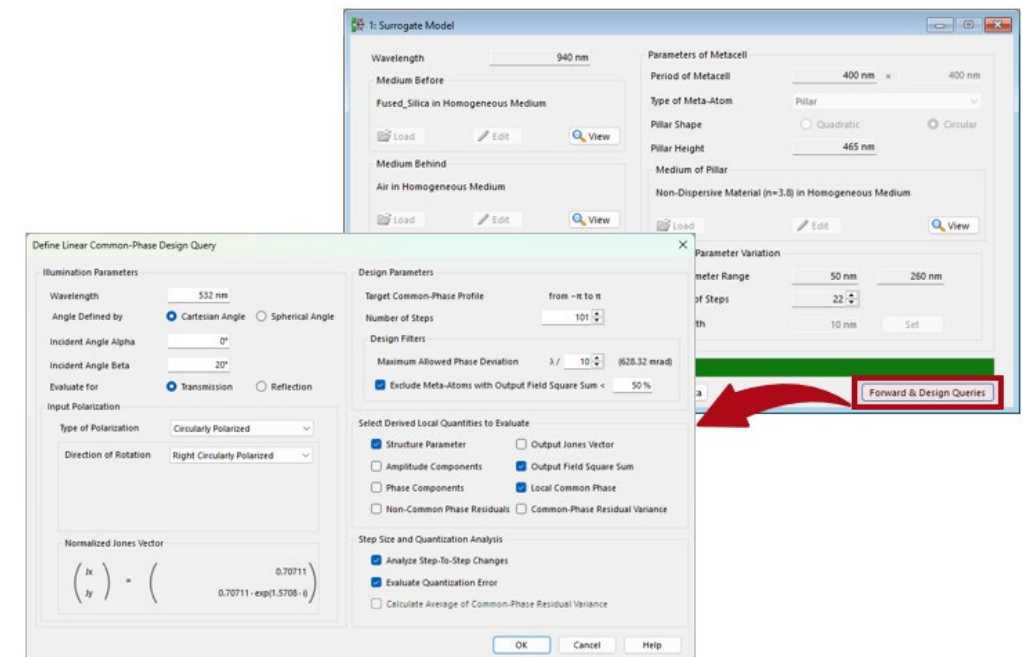


Design Queries

Use Design Query to find the structure parameters required to realize a desired phase transition and evaluate the resulting design quality.

Document ID: FD-META-DESIGNQ
 Version: 1.0
 Date: July 27, 2026
 Author: LightTrans International GmbH
 Version: 2026.2
 Package: Flat Lens Package

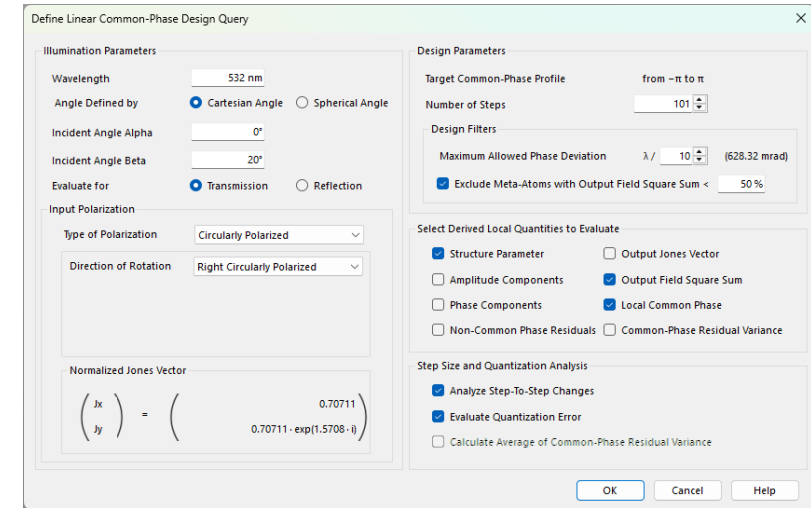


What Can Design Queries Be Used For?

⚠ From Target Phase to Structure Parameters

- Design Query works in the inverse direction of a Forward Query.
- The user specifies a desired Local Common Phase value.
- The tool finds the structure parameter that best realizes this target phase.

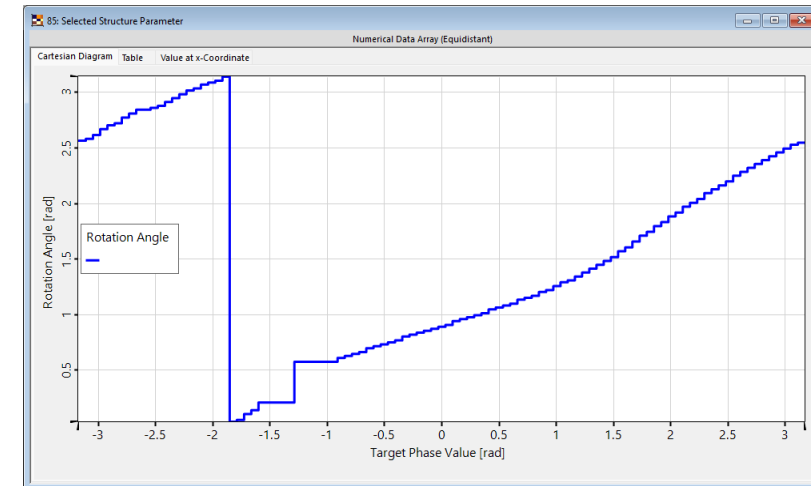
Get more information about our Surrogate Models [here!](#)



The dialog box is titled "Define Linear Common-Phase Design Query". It is divided into several sections:

- Illumination Parameters:**
 - Wavelength: 532 nm
 - Angle Defined by: ☒ Cartesian Angle, ☐ Spherical Angle
 - Incident Angle Alpha: 0°
 - Incident Angle Beta: 20°
 - Evaluate for: ☒ Transmission, ☐ Reflection
- Input Polarization:**
 - Type of Polarization: Circularly Polarized
 - Direction of Rotation: Right Circularly Polarized
- Normalized Jones Vector:**
$$\begin{pmatrix} J_x \\ J_y \end{pmatrix} = \begin{pmatrix} 0.70711 \\ 0.70711 \cdot \exp(1.5708 \cdot i) \end{pmatrix}$$
- Design Parameters:**
 - Target Common-Phase Profile: from $-\pi$ to π
 - Number of Steps: 101
 - Design Filters:**
 - Maximum Allowed Phase Deviation: $\lambda / 10$ (628.32 mrad)
 - ☒ Exclude Meta-Atoms with Output Field Square Sum < 50 %
 - Select Derived Local Quantities to Evaluate:**
 - ☒ Structure Parameter, ☐ Output Jones Vector
 - ☐ Amplitude Components, ☒ Output Field Square Sum
 - ☐ Phase Components, ☒ Local Common Phase
 - ☐ Non-Common Phase Residuals, ☐ Common-Phase Residual Variance
 - Step Size and Quantization Analysis:**
 - ☒ Analyze Step-To-Step Changes
 - ☒ Evaluate Quantization Error
 - ☐ Calculate Average of Common-Phase Residual Variance

Buttons: OK, Cancel, Help



Rotation angle vs target phase

Demo Surrogate Model Investigation

📈 Surrogate Model Parameters

Parameter	Value
Type	Nanofins
Wavelength	532 nm
Polarization	Right circular polarisation
Incidence angle range	-20° - 20° (11 × 11 steps)

📈 Design Query

Varied parameter	Value
Incident angle alpha	0°
Incidence angle beta	- 20°
Maximum allowed phase derivation	$\lambda / 10$
Exclude Meta-Atoms with Output Field Square Sum <	50 %

Define Linear Common-Phase Design Query

Illumination Parameters

Wavelength: 532 nm

Angle Defined by: ☒ Cartesian Angle ☐ Spherical Angle

Incident Angle Alpha: 0°

Incident Angle Beta: 20°

Evaluate for: ☒ Transmission ☐ Reflection

Design Parameters

Target Common-Phase Profile: from - π to π

Number of Steps: 101

Design Filters

Maximum Allowed Phase Deviation: $\lambda / 10$ (628.32 mrad)

☒ Exclude Meta-Atoms with Output Field Square Sum < 50 %

Input Polarization

Type of Polarization: Circularly Polarized

Direction of Rotation: Right Circularly Polarized

Normalized Jones Vector

$$\begin{pmatrix} J_x \\ J_y \end{pmatrix} = \begin{pmatrix} 0.70711 \\ 0.70711 \cdot \exp(1.5708 \cdot i) \end{pmatrix}$$

Select Derived Local Quantities to Evaluate

☒ Structure Parameter ☐ Output Jones Vector

☐ Amplitude Components ☒ Output Field Square Sum

☐ Phase Components ☒ Local Common Phase

☐ Non-Common Phase Residuals ☐ Common-Phase Residual Variance

Step Size and Quantization Analysis

☒ Analyze Step-To-Step Changes

☒ Evaluate Quantization Error

☐ Calculate Average of Common-Phase Residual Variance

OK Cancel Help

Please find the surrogate model in the corresponding files as:
Surrogate_Nanofins.sur

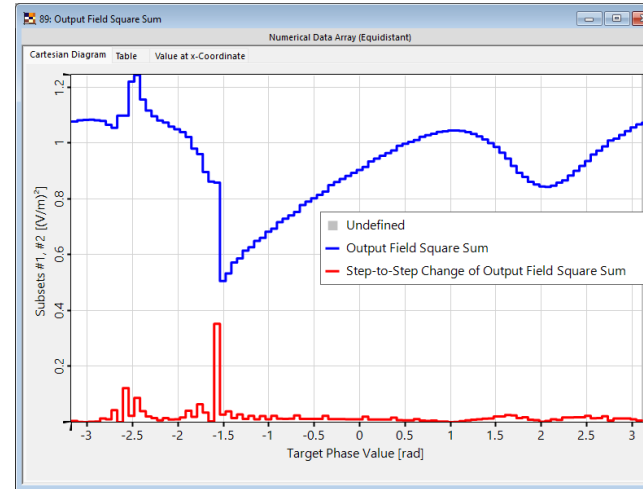
There are no OS-files necessary to repeat the content of this feature demonstration.

Results

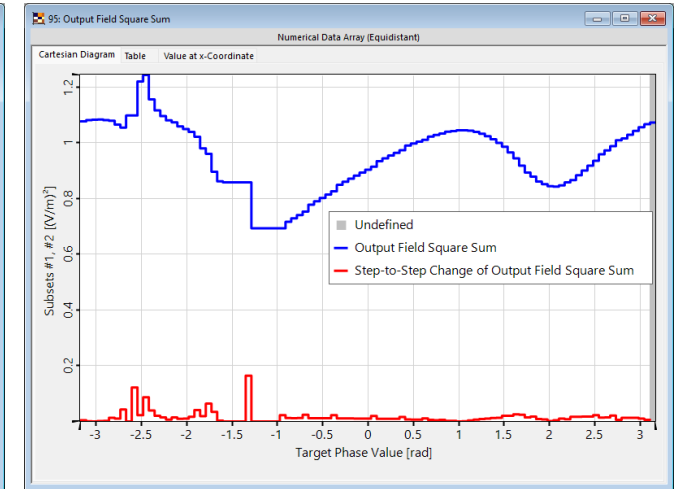
💡 Main Observation

- The Design Query returns the rotation angles required to generate the $-\pi$ to $+\pi$ phase transition.
- The Local Common Phase follows the target phase well.
- The Output Field Square Sum reveals a clear dip near a target phase of about -1.3 rad.
- This resonance can be filtered away, improving overall efficiency on the cost of phase effects.

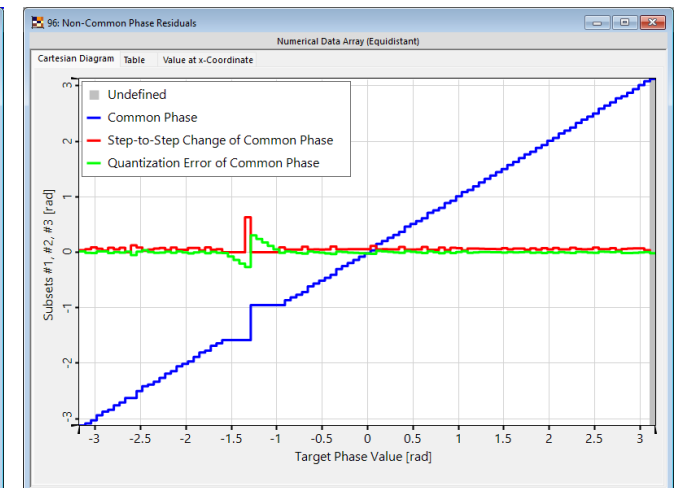
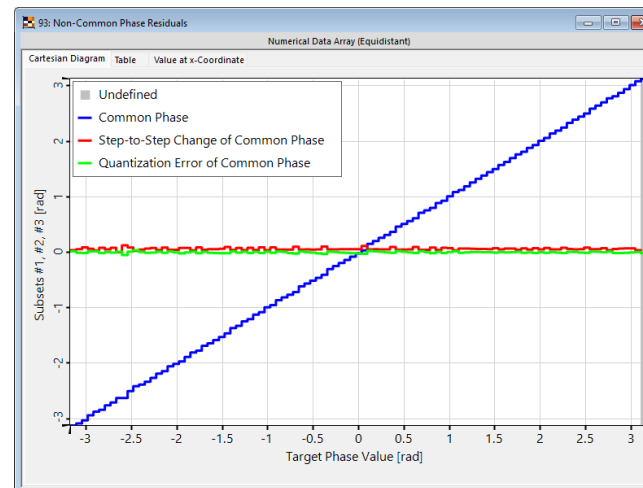
Without filter



Without filter



Output field
square sum

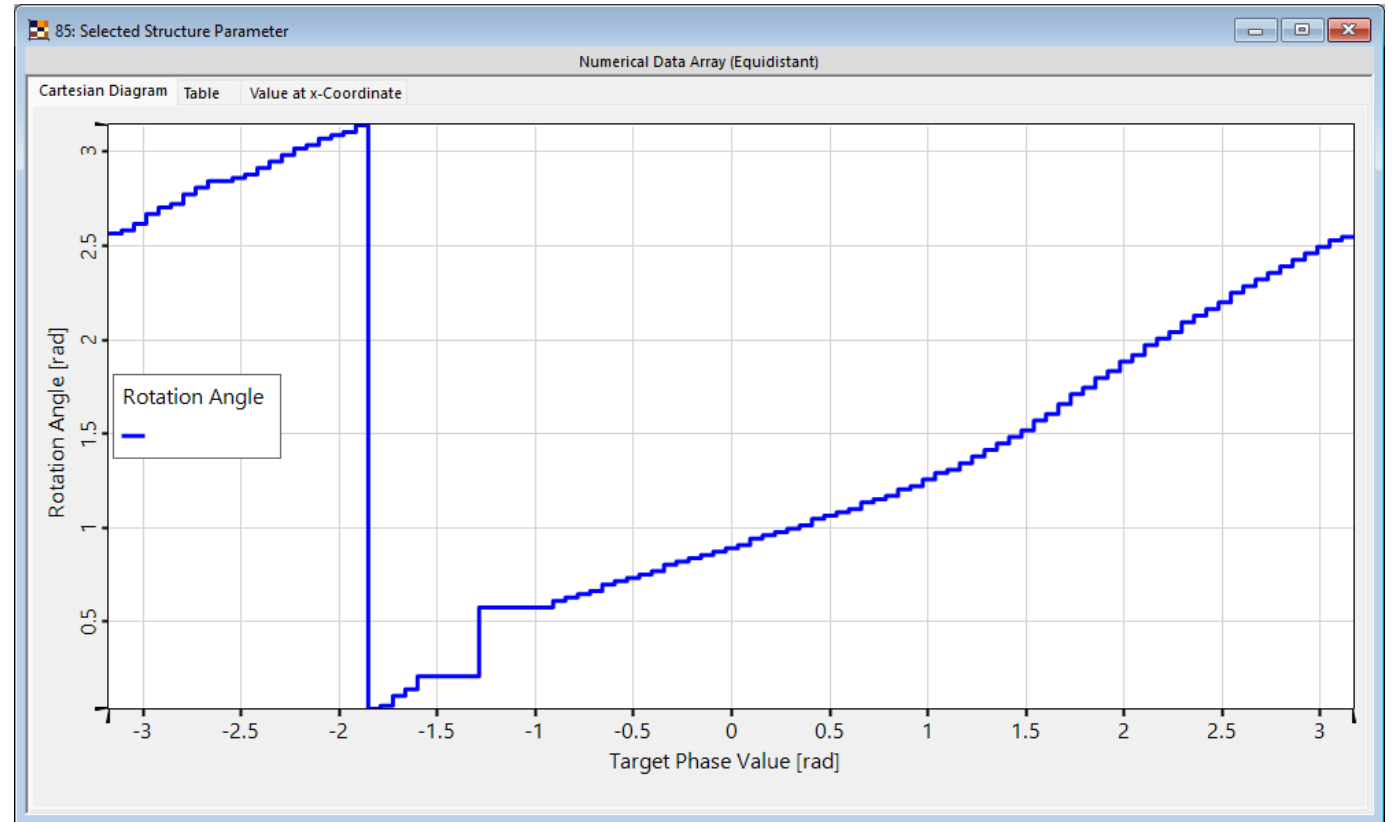


Local Common
Phase Residuals

Results

💡 Main Observation

- The Design Query returns the rotation angles required to generate the $-\pi$ to $+\pi$ phase transition.
- The Local Common Phase follows the target phase well.
- The Output Field Square Sum reveals a clear dip near a target phase of about -1.3 rad.
- This resonance can be filtered away, improving overall efficiency on the cost of phase effects.

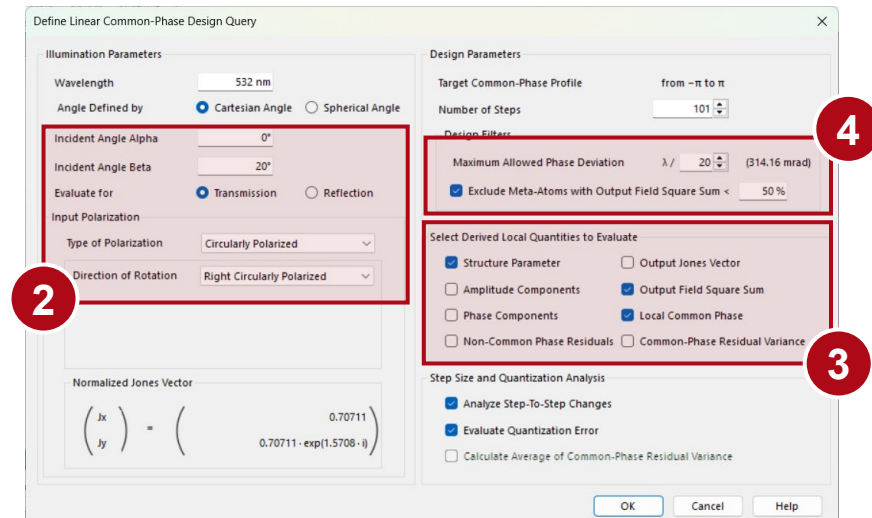
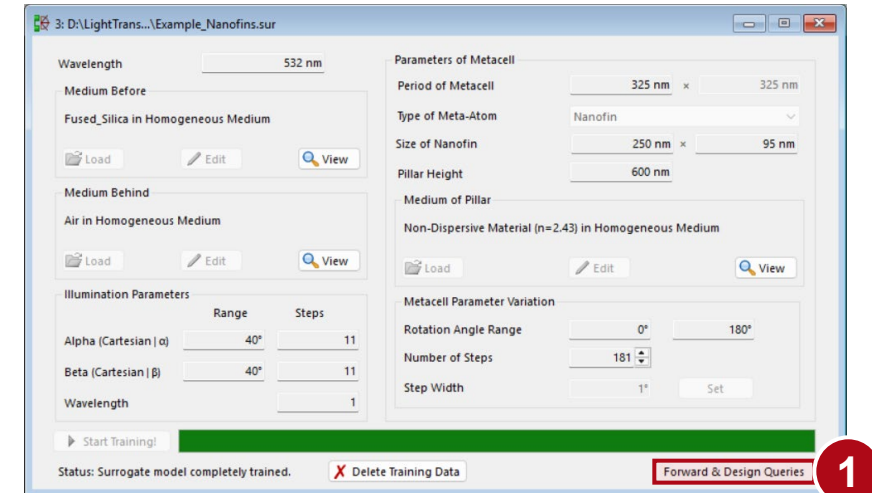


Rotation angle vs target phase value

Workflow

1 What the User Does

1. Open the surrogate model file with the pre-trained nanopillar surrogate model.
2. Click *Forward & Design Queries*. Pick *Design Related Scan*.
3. Choose *Right Circular Polarization* and 20° Incident Angle Beta.
4. Select *Output Field Square Sum* and *Local Common Phase* as outputs.
5. Press OK
6. Repeat the previous steps but this time also active *Exclude Meta-Atoms with Output Field Square Sum* and set it to 50%



Related Documents

White Papers

- [WP-META-SURROGATE — Surrogate Modeling: Enabling Practical Metalens Design and Simulation](#)
- [WP-META-PHASE — Designing and Analyzing the Phase Response of Metasurfaces](#)

Use Cases and Feature Demos

- [Collimation with a Metalens Based on Nanopillars](#)
- [Aberration Control via Metalens](#)
- [Wavefront Phase Modifier Twins](#)
- [Forward Queries](#)

Tutorials

- [Designing a Metalens in VirtualLab Fusion](#)

Designing a Metalens in VirtualLab Fusion

Overview

This tutorial walks you through the complete design and simulation workflow for a metalens in VirtualLab Fusion. A metalens is realized as an **Optical Digital Twin** – an intelligent replica that encapsulates its own simulation model – and can be accessed via the **Digital Twin Hub**.

The workflow consists of four main steps:

1. **Configure the metalens** – specify the optical environment and define the target phase profile
2. **Create a surrogate model** – define the meta-atom parameter space and train the neural network
3. **Design and simulate** – map the phase profile to discrete meta-atoms and analyze performance
4. **Export the structure** – generate a GDSII file for fabrication