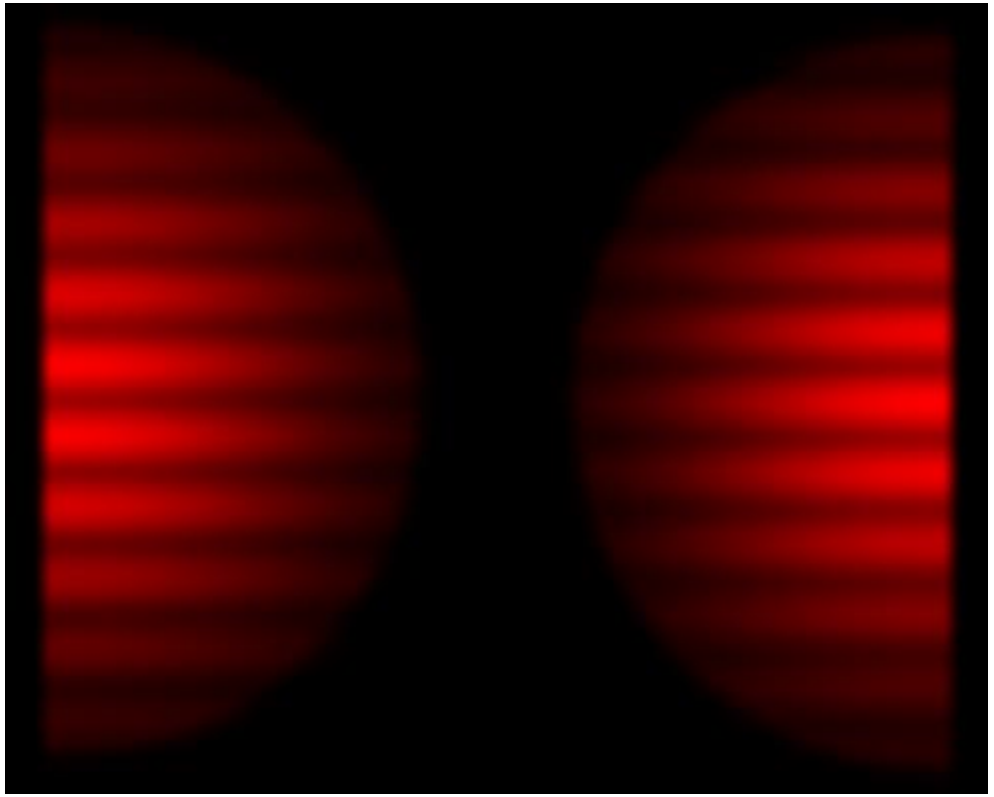
Modeling and Analysis of Wedged Reversal Shearing Interferometry

Abstract

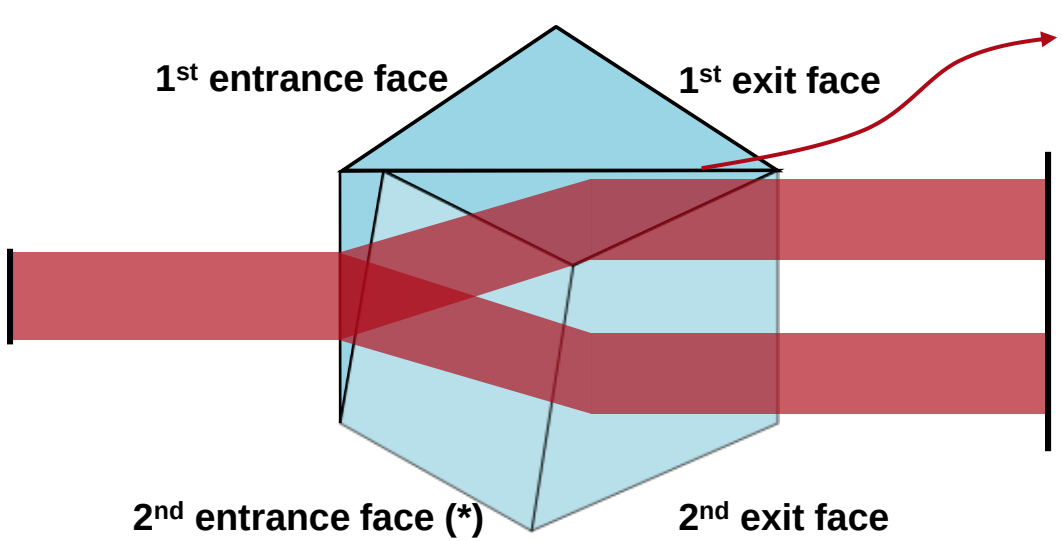


Unlike common interferometers that are often restricted by the temporal behavior of the impinging light, the wedged reversal interferometer offers a more stable approach to conduct beam characterization.

In this use case, we demonstrate how such an interferometer can be realized in VirtualLab Fusion and we evaluate an interference pattern in case of system exposure to mechanical and environmental vibrations.

Modeling Task

input field
- Gaussian wave
- waist radius: 700 µm
- wavelength 800 nm
- polarization along-x

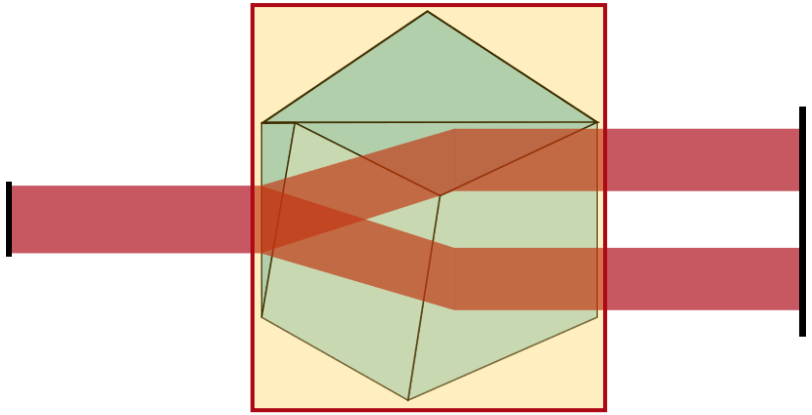


detector
- irradiance
  (to evaluate interference pattern)

beam splitter cube
- 2 glass (Fused Silica) prisms with a separating coating
- coating ref. index: 1.5
- coating thickness: 390 nm
- beam splitter rotation: 45°
- **(*)** 2nd entrance face wedge angle: 0.12° (to be varied)

(*) *The wedge angle in the figure is exaggerated for demonstration purposes.*

Connected Modeling Techniques: Prism Cube

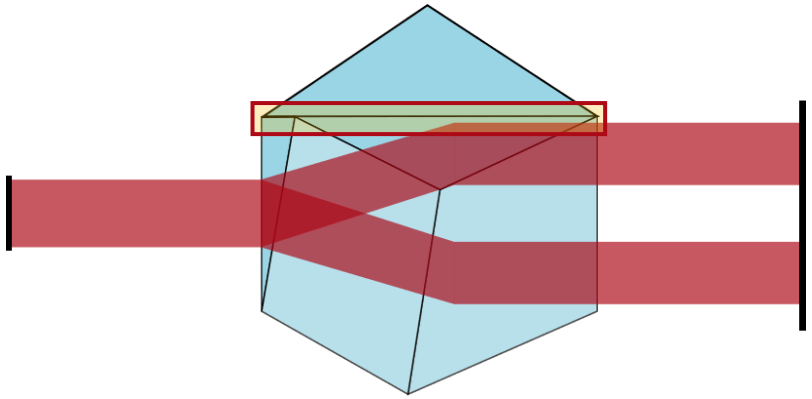


Available modeling techniques for interaction with surfaces:

Methods	Preconditions	Accuracy	Speed	Comments
Functional Approach	-	Low	Very High	No Fresnel Losses
S-matrix	Planar surface	High	High	Rigorous model; includes evanescent waves; k-domain
Local Plane Interface Approximation	Surface not in focal region of beam	High	High	Local application of S-matrix; LPIA; x-domain

In general, complex three-dimensional configurations like prism or beam splitter cubes can be realized as a combination of surfaces.

Connected Modeling Techniques: Separating Coating



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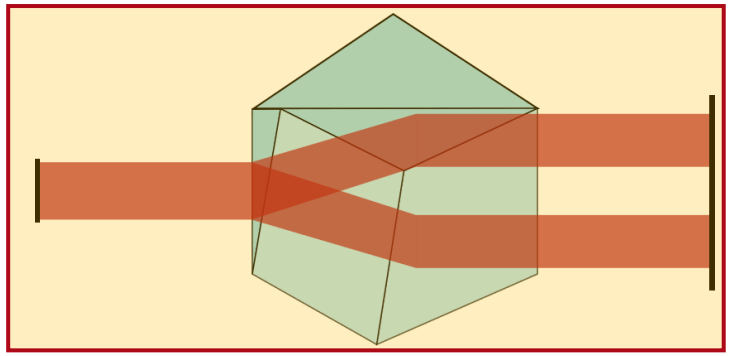
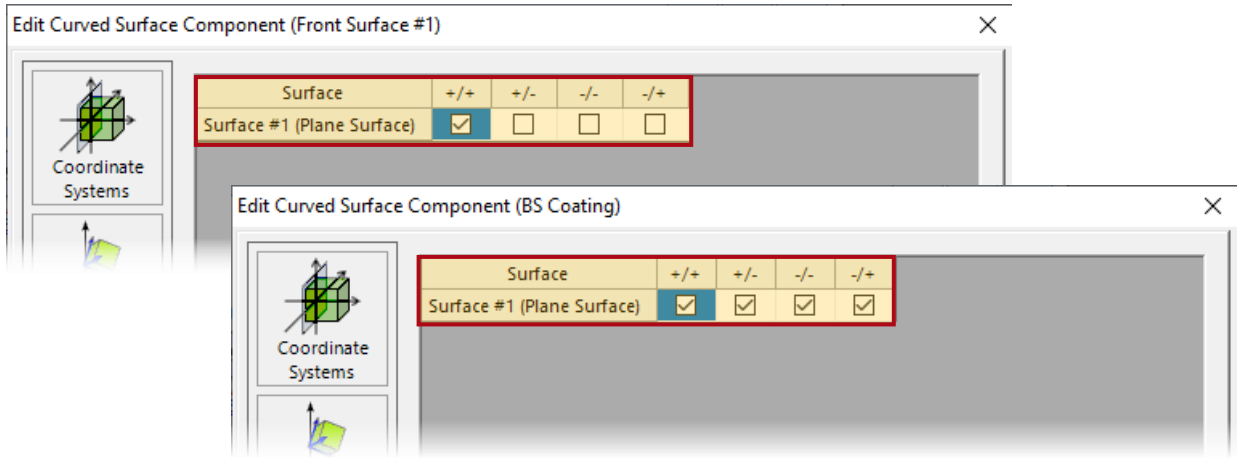
For modeling of the separating coating, the rigorous S-matrix/Layer Matrix algorithm is applied, developed precisely for an x, y-invariant layered structure.

There is also the possibility to import the coating layer(s) into VirtualLab Fusion. For further information:

Import Coating into VirtualLab Fusion

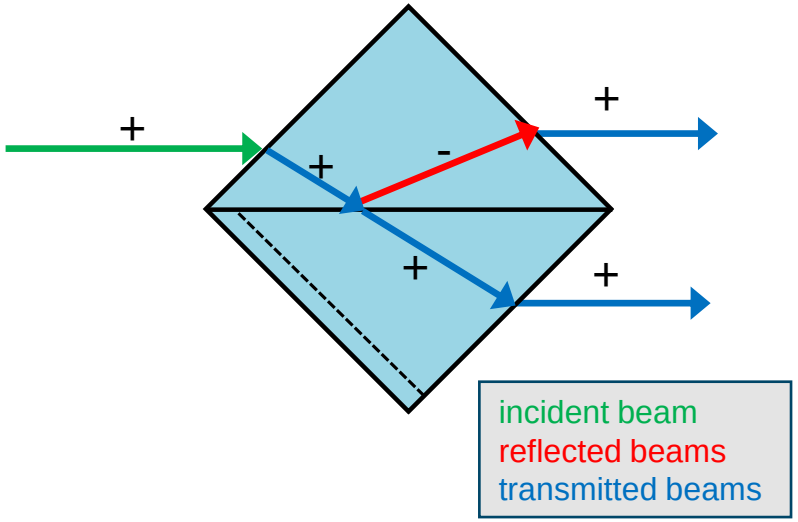
Non-Sequential Tracing





With the channel configuration mode set to *Manual Configuration*, the user can specify which light paths are followed in the simulation, for each surface in the system individually. When the simulation is performed, the available light paths are determined by the so-called *Light Path Finder*. The field is then traced along these paths through the configured setup.

channel definition of the light paths (top view)



Channel Setting for Non-Sequential Tracing

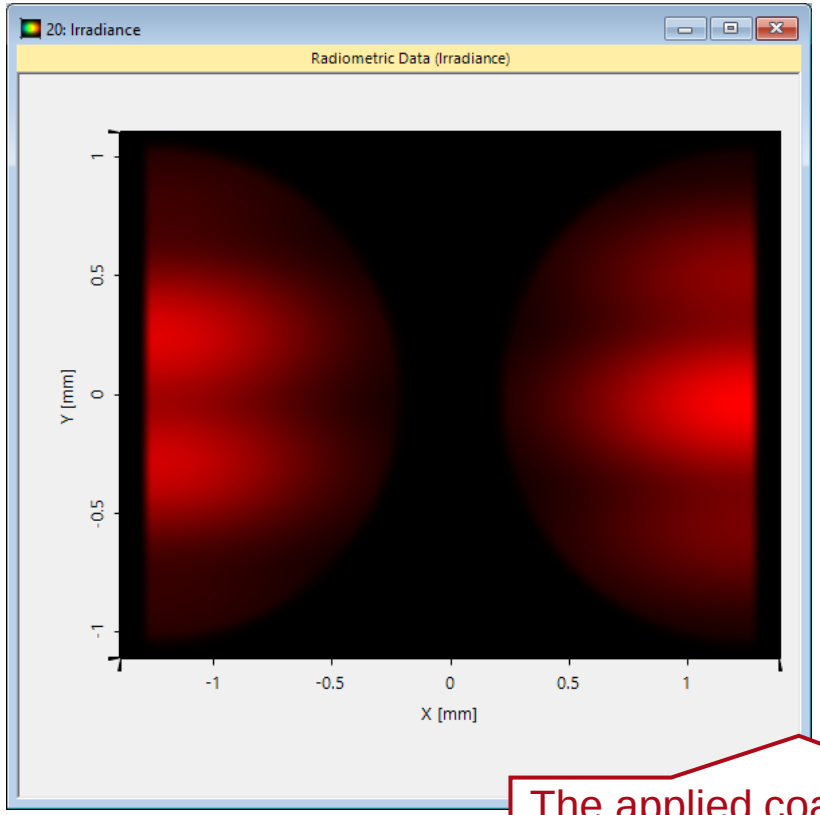
Interference Pattern

To investigate the interference effects introduced by the prism consisting of a wedged side, we set up the system to perform the simulation neglecting diffraction effects, by only allowing *Pointwise Fourier Transforms*.

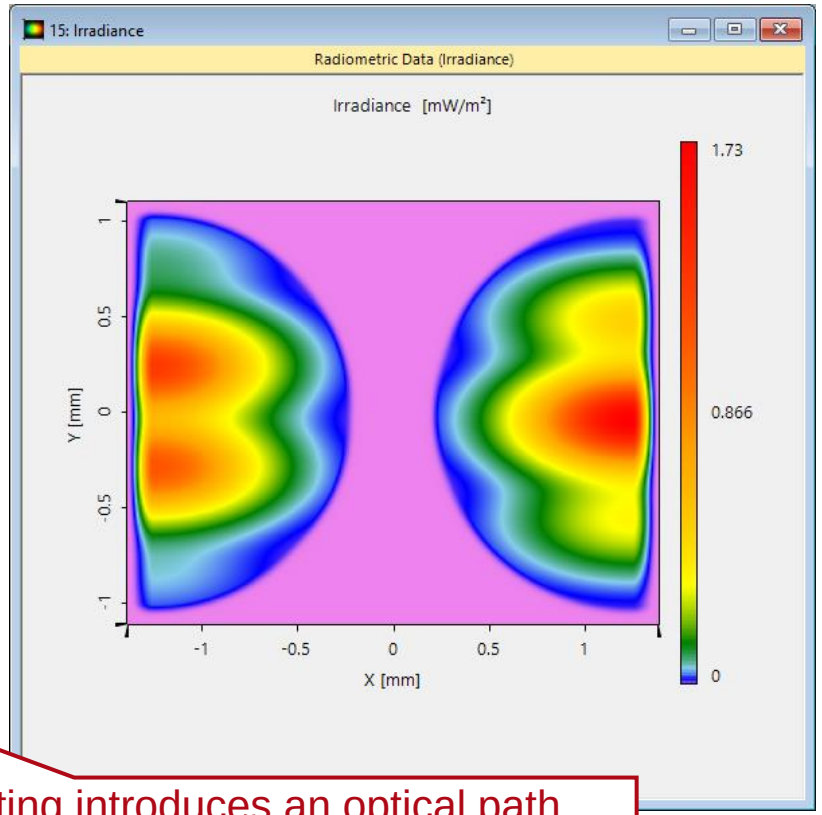
For further details on this topic, please see:

Configuring Your Simulation in VirtualLab Fusion

Irradiance (real color)

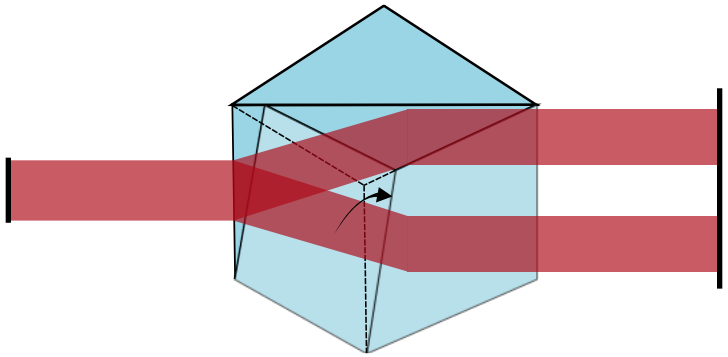


Irradiance (logarithmic reverse rainbow)



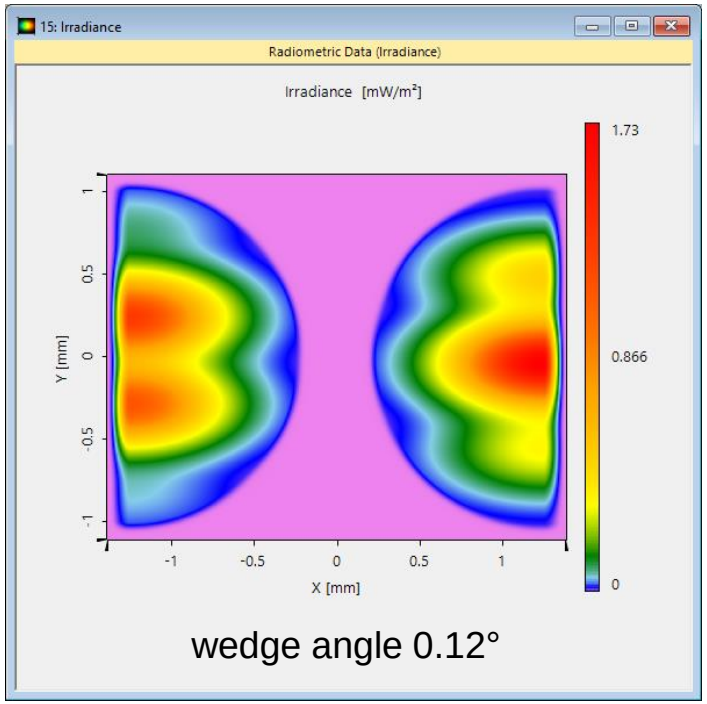
The applied coating introduces an optical path difference and hence phase difference, resulting in an asymmetric interference pattern.

Interference Pattern vs. Wedge Angle

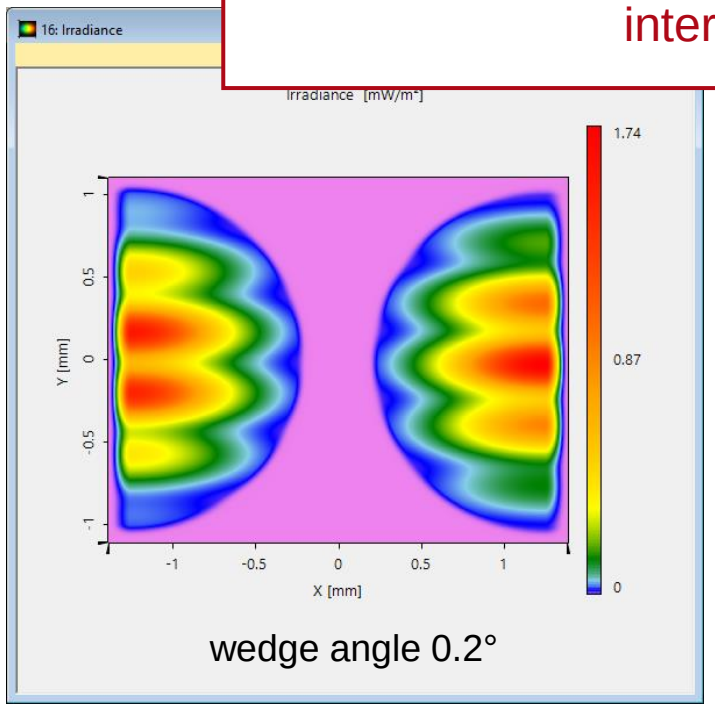


inward rotation of the 2nd entrance face

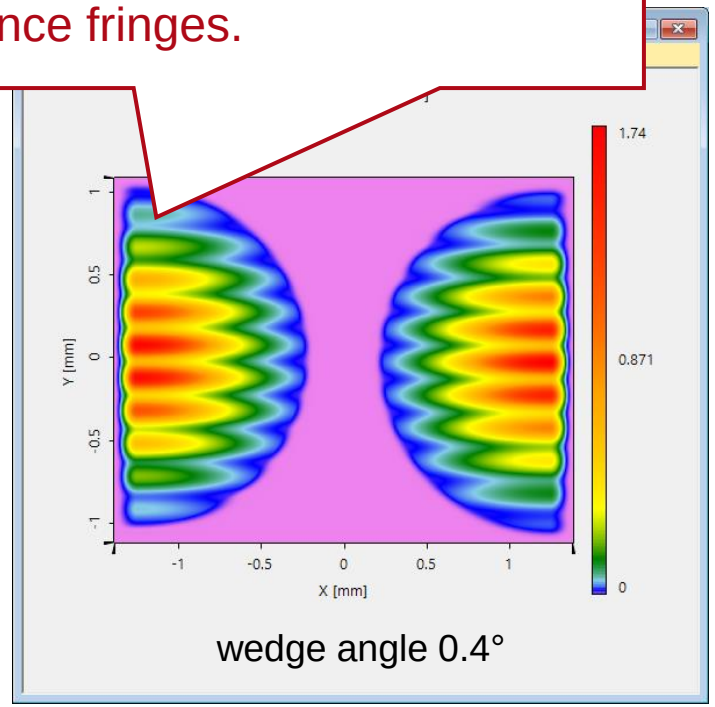
Larger wedge angles result in appearance of more interference fringes.



wedge angle 0.12°

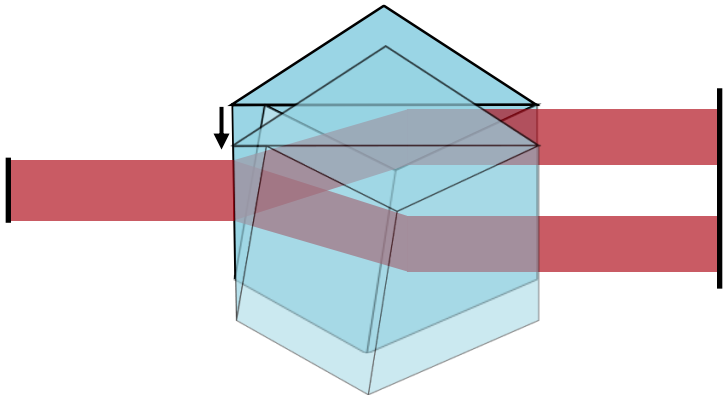


wedge angle 0.2°

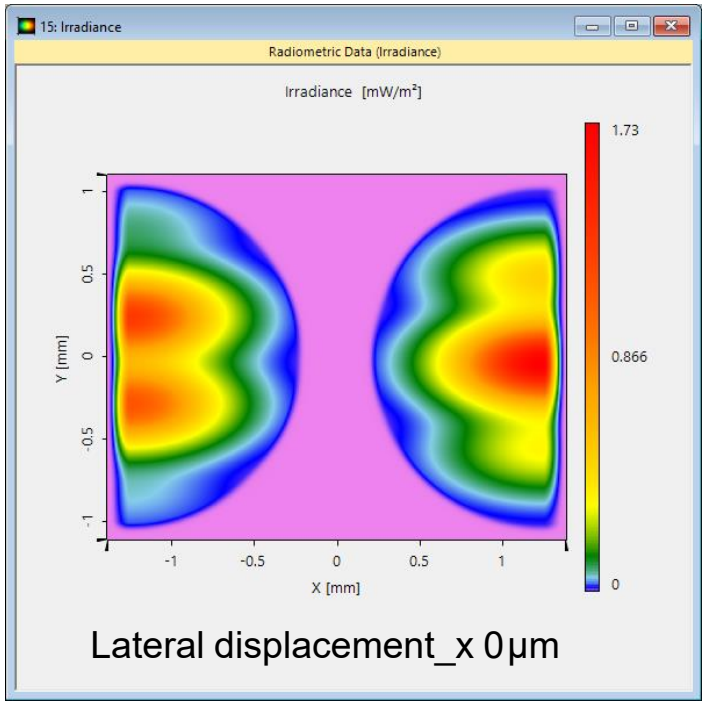


wedge angle 0.4°

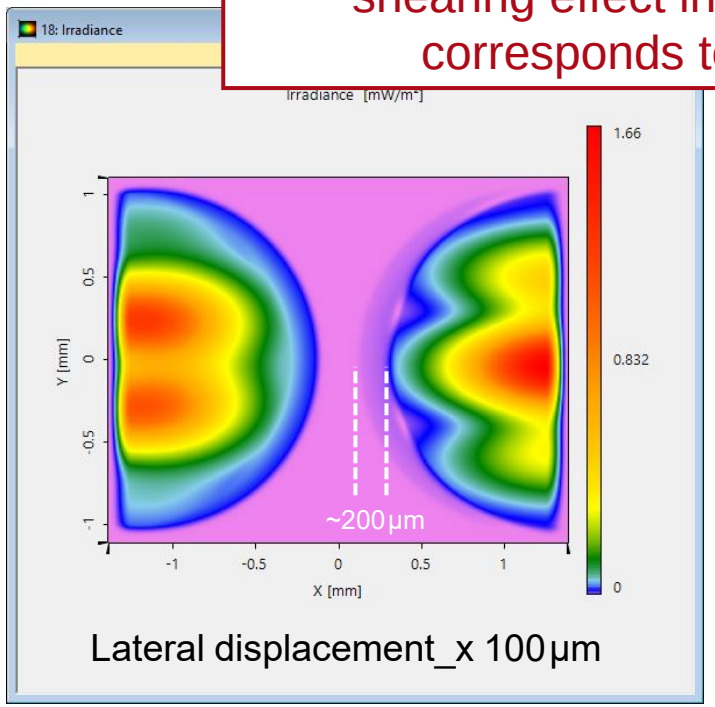
Interference Pattern vs. Lateral Displacement



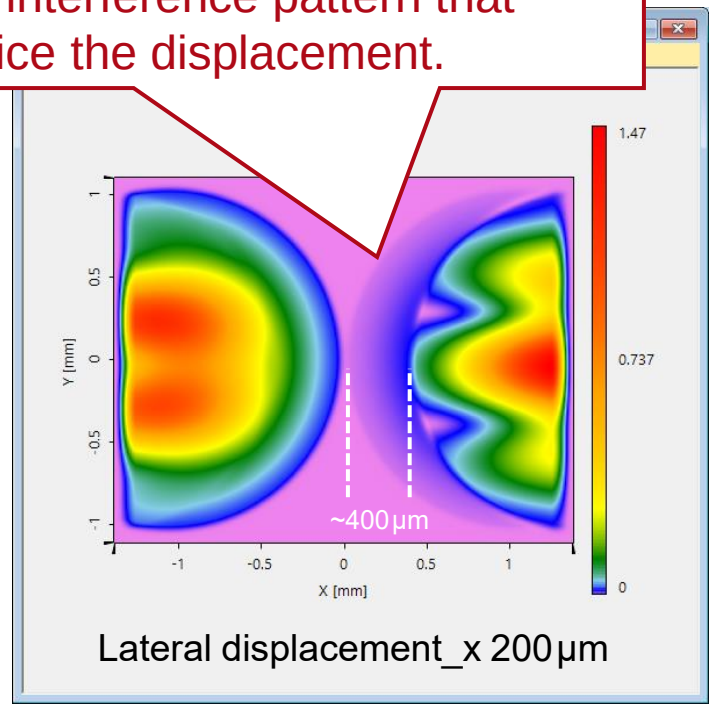
The lateral displacement of the prism/source causes a shearing effect in the interference pattern that corresponds to twice the displacement.



Lateral displacement_x 0 µm



Lateral displacement_x 100 µm



Lateral displacement_x 200 µm

Document Information

title	Modeling and Analysis of Wedged Reversal Shearing Interferometry
document code	IFO.0024
document version	1.0
required packages	• VirtualLab Fusion Standard
software version	2023.2 (Build 2.30)
category	Application Use Case
further reading	• Collimation Testing with Shearing Interferometry • Stratified Media Component • Channel Setting for Non-Sequential Tracing • Laser-Based Michelson Interferometer and Interference Fringe Exploration • Mach-Zehnder Interferometer

Import Coatings into VirtualLab Fusion