Single Grating Interferometer for X-Ray Imaging
Abstract

X-ray imaging is often based on the Talbot effect and the self-image of gratings. Following the work of N. Morimoto et al., we selected three types of phase gratings, with cross, checkerboard, and mesh patterns. The gratings are employed in a single grating interferometer, modeled as phase-only transmission functions (because the x-ray wavelength is much smaller than the grating period), and their self-images are examined in VirtualLab Fusion.
Modeling Task

How to investigate the self-images behind phase gratings with different patterns for x-ray imaging?

Input field:
- Point source
- X-ray at 8keV (wavelength 0.155nm)

Phase grating:
- Different patterns

Cross pattern
- 6µm

Checkerboard pattern
- 6µm

Mesh pattern
- 6µm

Modeling Task

Since the wavelength is much smaller comparing to the period, the gratings can be modeled by transmission functions.

How to investigate the self-images behind phase gratings with different patterns for x-ray imaging?

Cross-Pattern Phase Grating

Cross-pattern 0.6 µm x 6 µm self-image of cross-pattern phase grating

Input field:
- Point source
- X-ray at 8keV (wavelength 0.155nm)

Phase grating:
- 30mm
- 970mm

Self-image:
- 300 µm
Checkerboard-Pattern Phase Grating

checkerboard pattern

self-image of checkerboard phase grating
Mesh-Pattern Phase Grating

Mesh pattern

phase value

input field
- point source
- x-ray at 8keV (wavelength 0.155nm)

phase grating

self-image of cross-pattern phase grating

checkerboard distribution with half intensity in comparison with previous cases.

Data for Wavelength of 155 pm (1E-3 (V/m)^2)
Comparison of Different Cases

cross pattern
checkerboard pattern
mesh pattern

phase value

self-image
Peek into VirtualLab Fusion

flexible definition of arbitrary transmission via programming

diffraction-included calculation and convenient result visualization
Workflow in VirtualLab Fusion

• Specify or customize transmission functions
  - How to Work with the Programmable Function & Example (Cylindrical Lens) [Use Case]

• Select proper detector for field visualization
  - Electromagnetic Field Detector [Use Case]

• Set the Fourier transforms properly
  - Fourier Transform Settings – Discussion at Examples [Use Case]
VirtualLab Fusion Technologies

Field Solver

- Prisms, plates, cubes, ...
- Lenses & freeforms
- Apertures & boundaries
- Gratings
- Diffractive, Fresnel, meta lenses
- HOE, CGH, DOE
- Micro lens & freeform arrays
- SLM & adaptive beam splitters
- Diffractive components
- Waveguides & fibers
- Scatterer
- Diffusers
- Nonlinear components
- Free space
- Crystals & anisotropic components

Idealized component
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<td>- <a href="#">Fourier Transform Settings – Discussion at Examples</a></td>
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