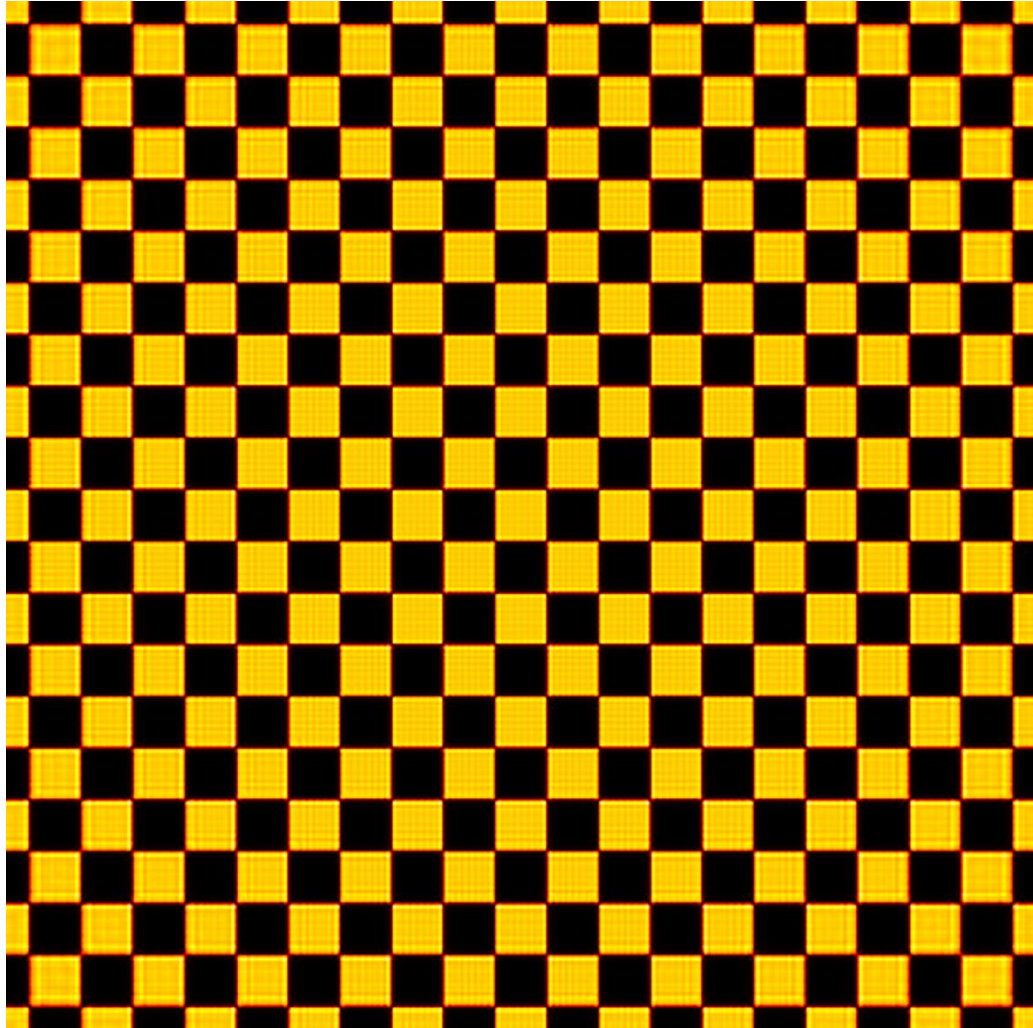


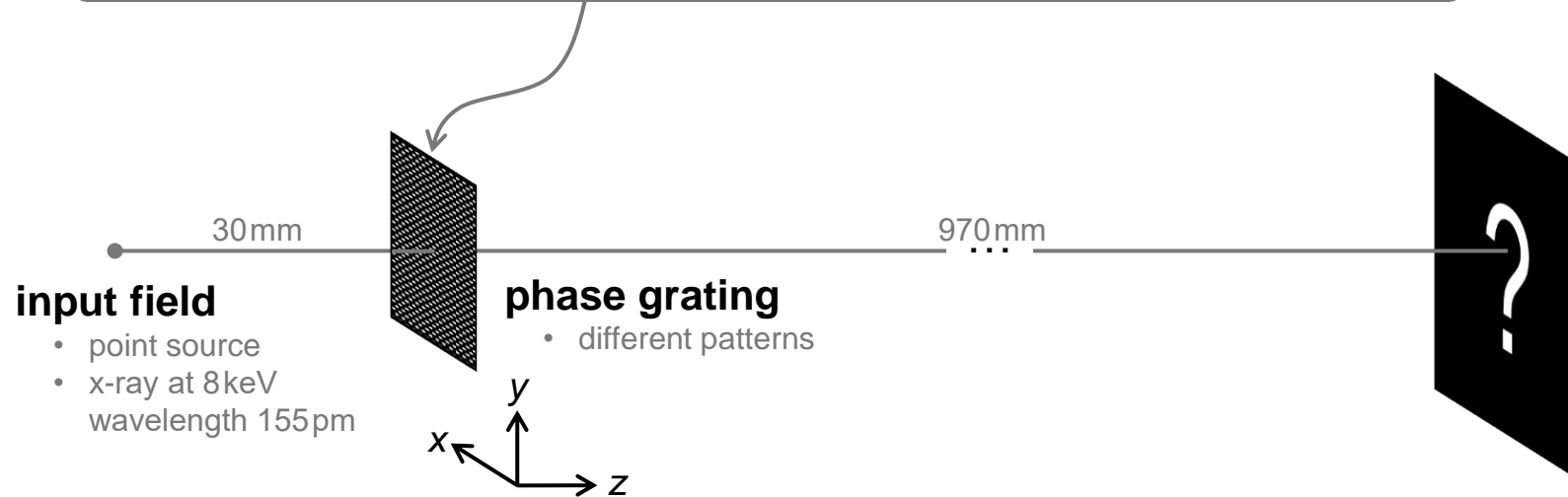
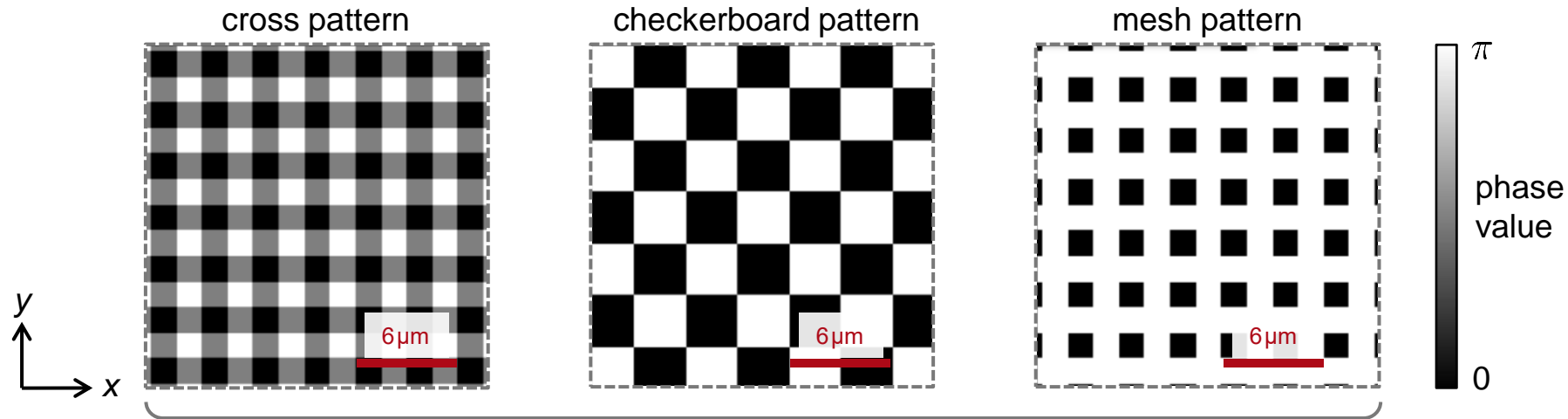
Single-Grating Interferometer for X-Ray Imaging

Abstract



X-ray imaging is often based on the Talbot effect, and the periodic self-imaging 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 smallest feature size of the grating), and their self-images are examined in VirtualLab Fusion.

Modeling Task



Modeling of phase gratings and subsequent simulation of the propagation to observe the self-images.

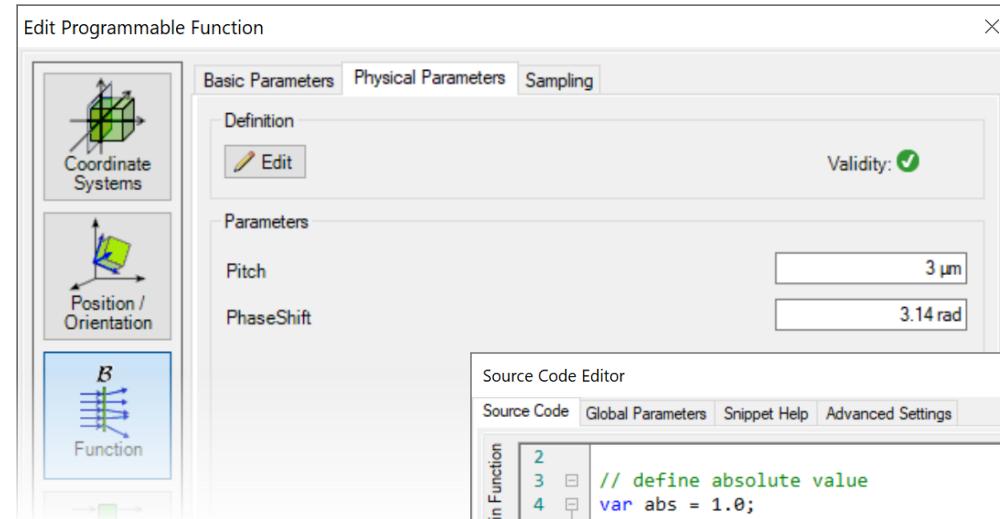
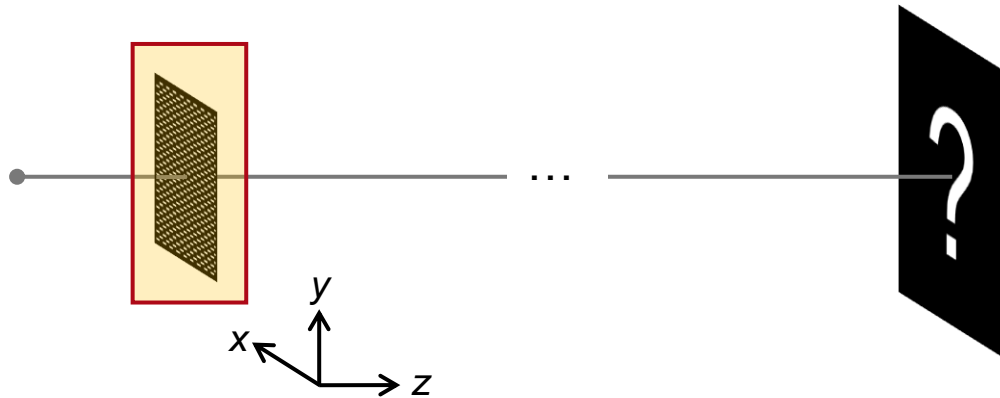
system parameters from N. Morimoto, *et al.*, Opt. Express 23, 29399-29412 (2015)

The Phase Grating

If the smallest features of a grating structure are larger than approximately five times the wavelength of the incident light, the resulting phase values are proportional to the structure.

As this condition is met in this use case, we simulate the gratings via a functional approach.

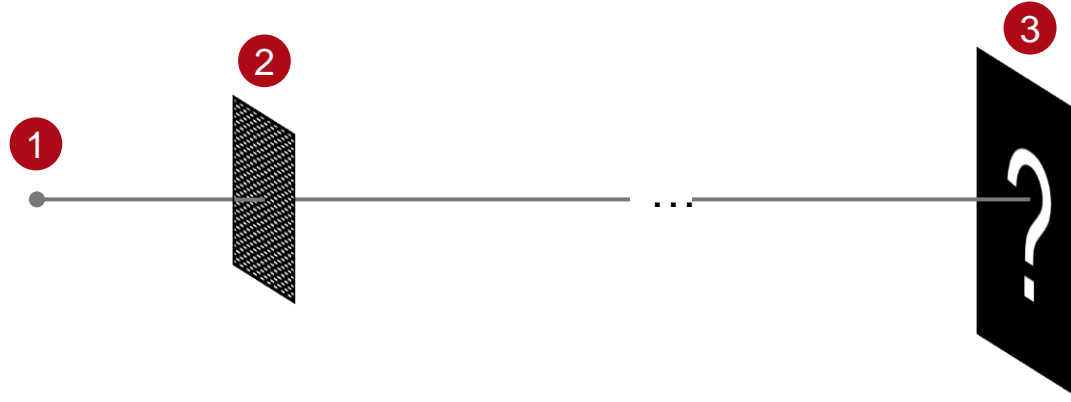
We use an ideal component in our optical setups, where the electromagnetic field is multiplied with a phase-only transmission function, which can be easily programmed.



flexible definition
of arbitrary
transmission via
programming in
VirtualLab Fusion

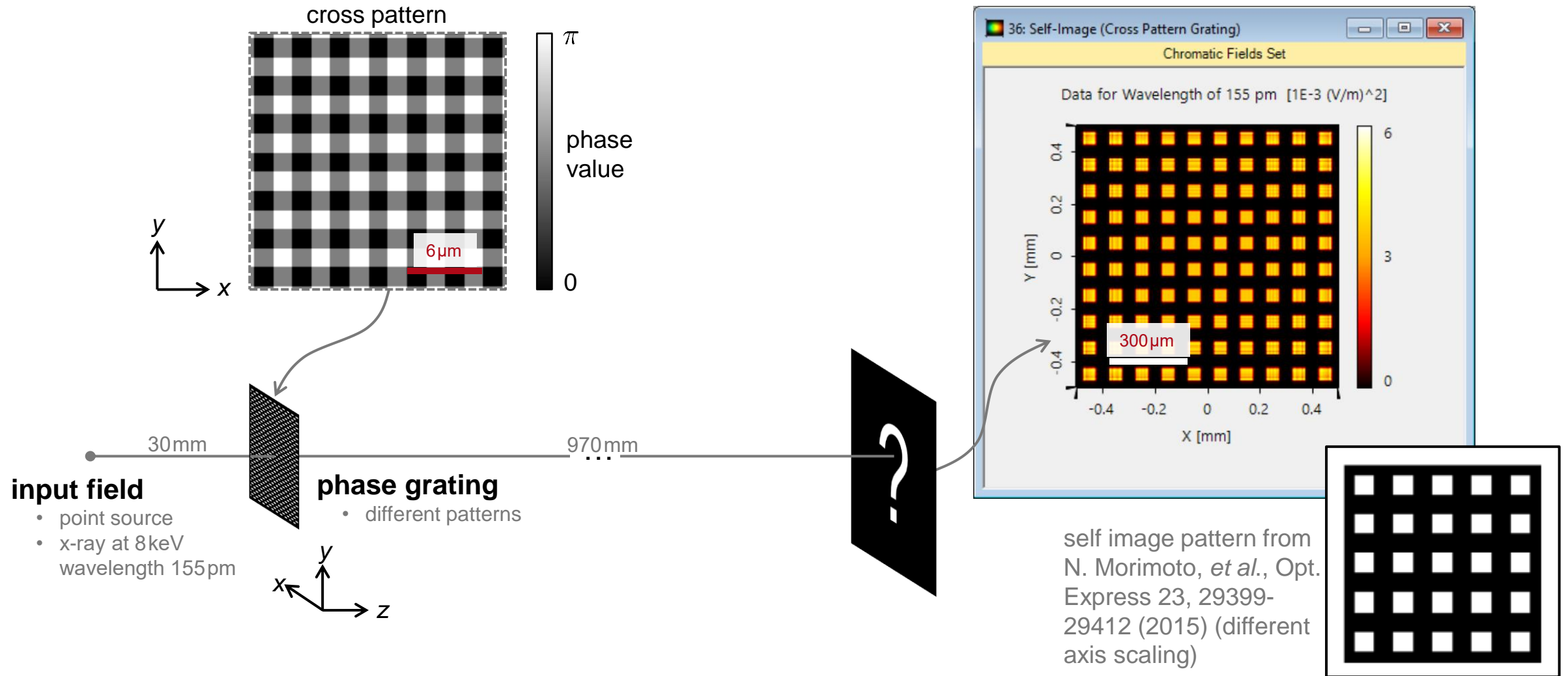
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Source Code Editor
Source Code Global Parameters Snippet Help Advanced Settings
Main Function
Snippet Body
2
3 // define absolute value
4 var abs = 1.0;
5
6 var ix = Math.Floor(x / Pitch);
7 var iy = Math.Floor(y / Pitch);
8
9 var refx = ix * Pitch;
10 var refy = iy * Pitch;
11
12 var dx = x - refx;
13 var dy = y - refy;
14
15 double arg = 0.0;;
16 if(dy <= 0.25 * Pitch){
17     if(dx > 0.25 * Pitch && dx <= 0.75 * Pitch){
18         arg = 0.5 * PhaseShift;
19     }
20 }
21 else if(dy > 0.75 * Pitch){
22     if(dx > 0.25 * Pitch && dx <= 0.75 * Pitch){
23         arg = 0.5 * PhaseShift;
24     }
25 }
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Summary – Components...

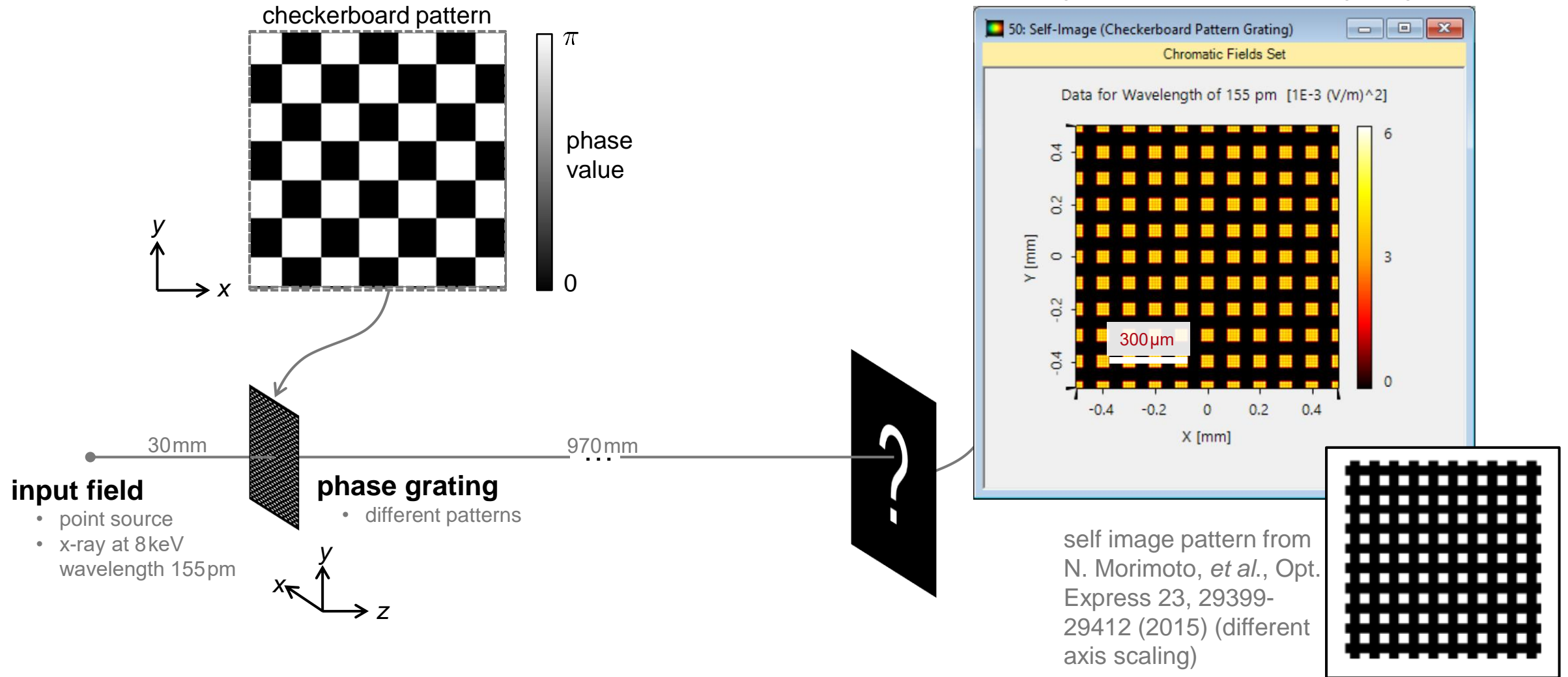


... of Optical System	... in VirtualLab Fusion	Model/Solver/Detected Magnitude
1. source	<i>Spherical Wave</i>	Spherical Wave
2. phase grating	<i>Programmable Function</i>	Phase Only Transmission Function
3. detector	<i>Camera Detector</i>	Energy Density Measurement

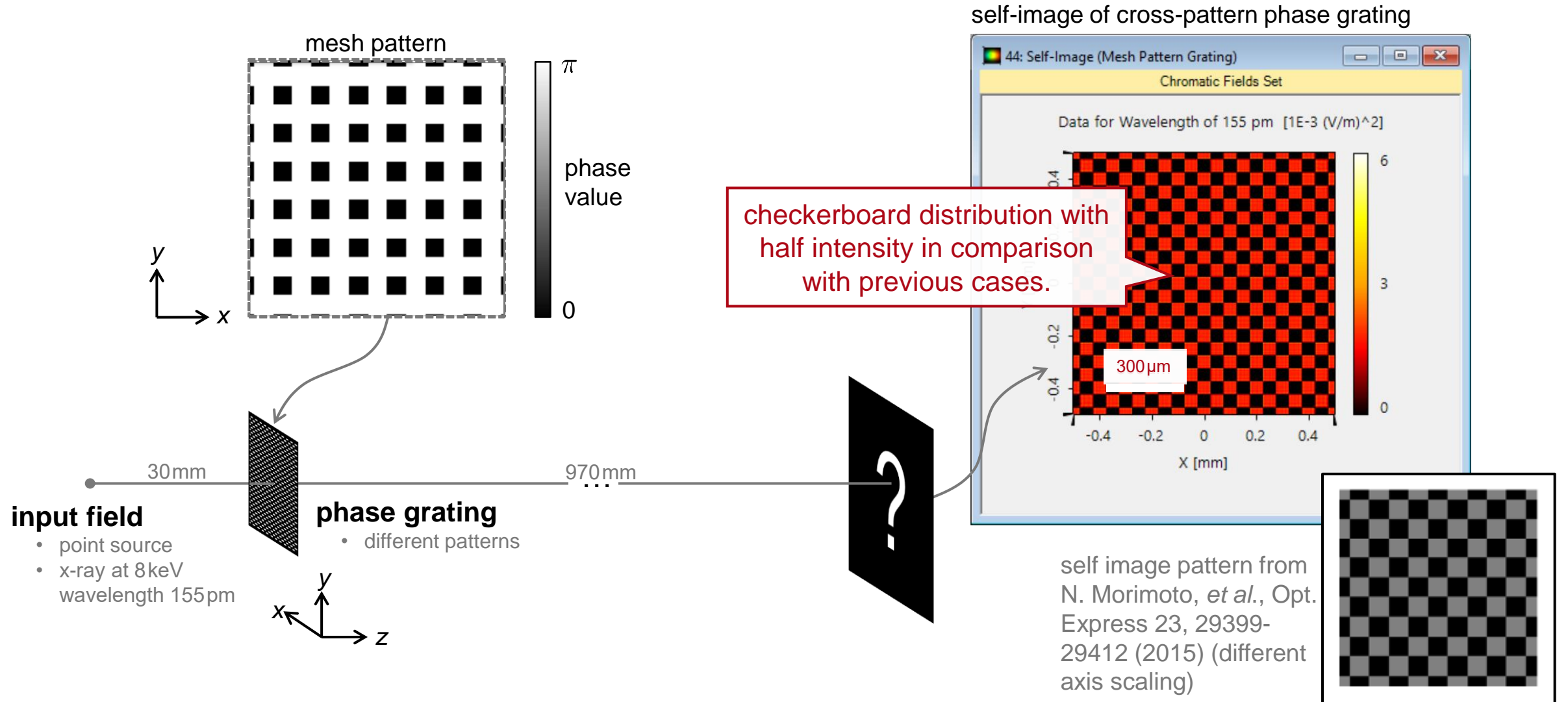
Cross-Pattern Phase Grating



Checkerboard-Pattern Phase Grating

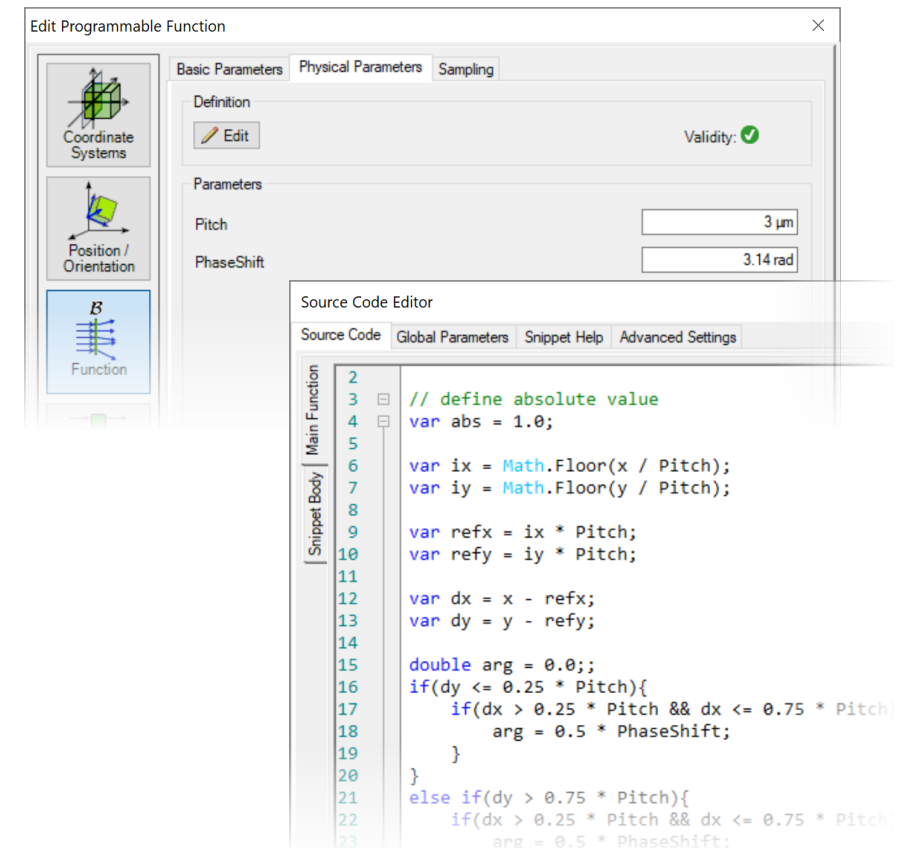


Mesh-Pattern Phase Grating

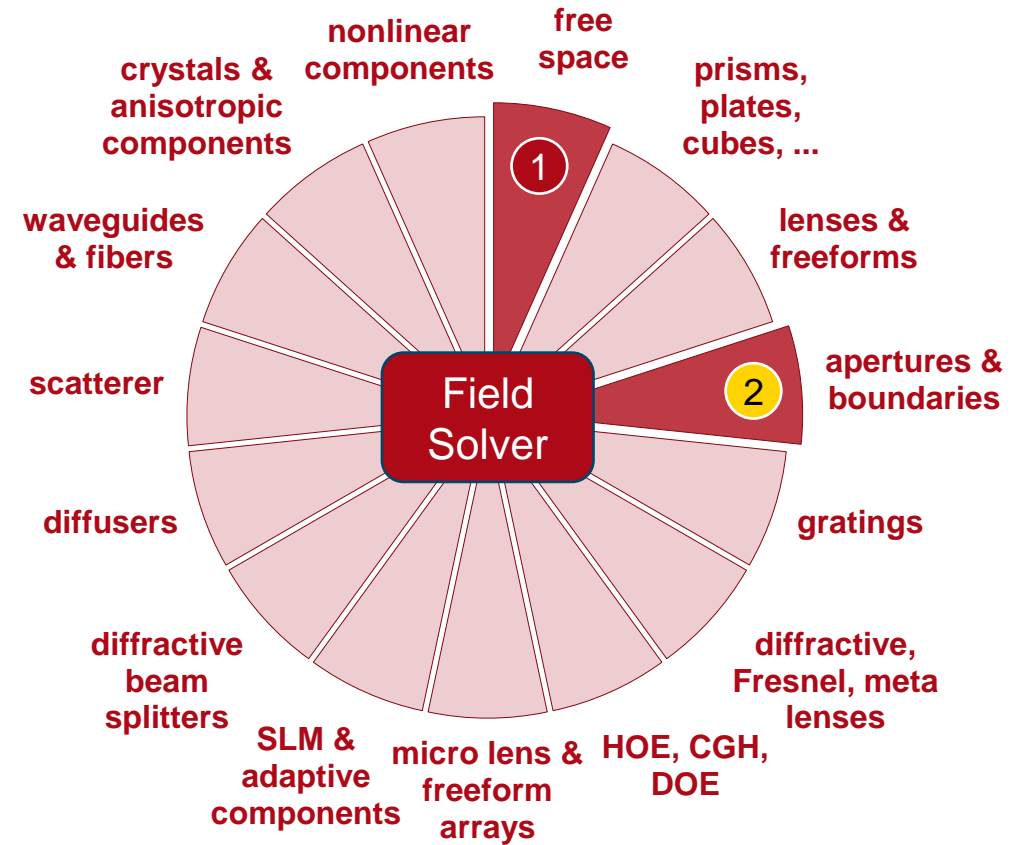
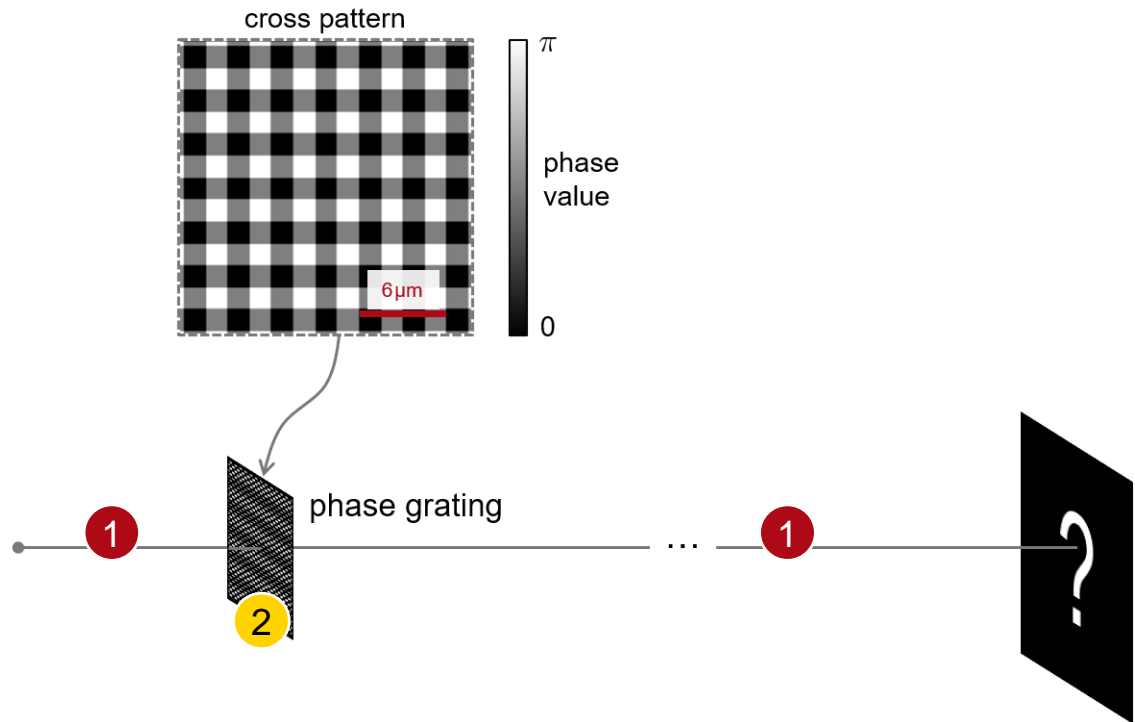


Workflow in VirtualLab Fusion

- 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



idealized component

Document Information

title	Single-Grating Interferometer for X-Ray Imaging
document code	MISC.0079
version	2.1
edition	VirtualLab Fusion Basic
software version	2023.1 (Build 1.556)
category	Application Use Case
further reading	<ul style="list-style-type: none">• <u>Modeling of the Talbot Effect</u>• <u>Fourier Transform Settings – Discussion at Examples</u>• <u>Diffraction Patterns behind Different Apertures</u>