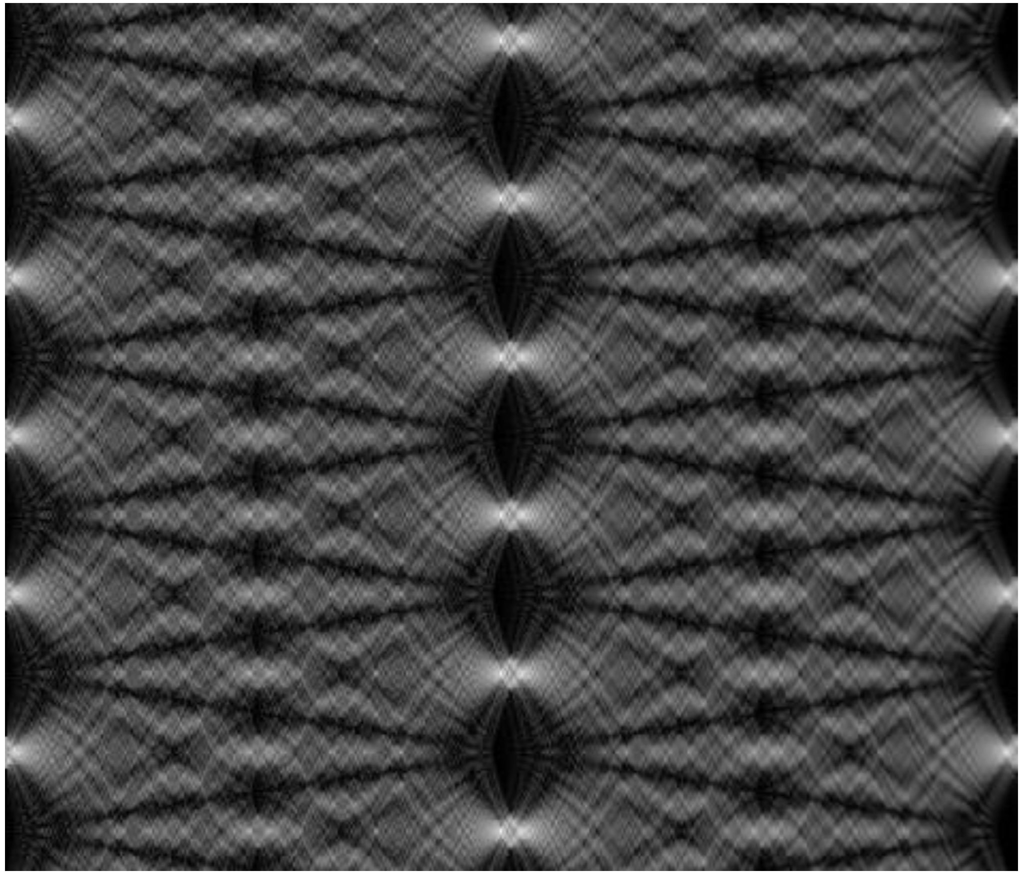
Modeling of the Talbot Effect

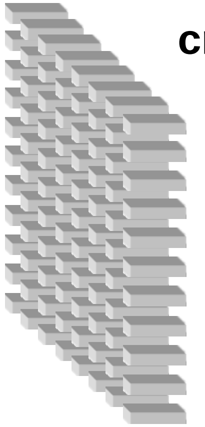
Abstract



The Talbot effect is a well-known near-field diffraction effect. When a periodic structure (e.g. a grating) is illuminated by collimated light, at certain regular intervals behind the grating it is possible to observe its reconstructed image. The specific distance that separates these planes is called the Talbot distance, after Henry Fox Talbot, who first observed this effect in 1836. In this example we demonstrate the modeling of the Talbot effect (also recreating the Talbot carpet) with the fast physical optics software VirtualLab Fusion.

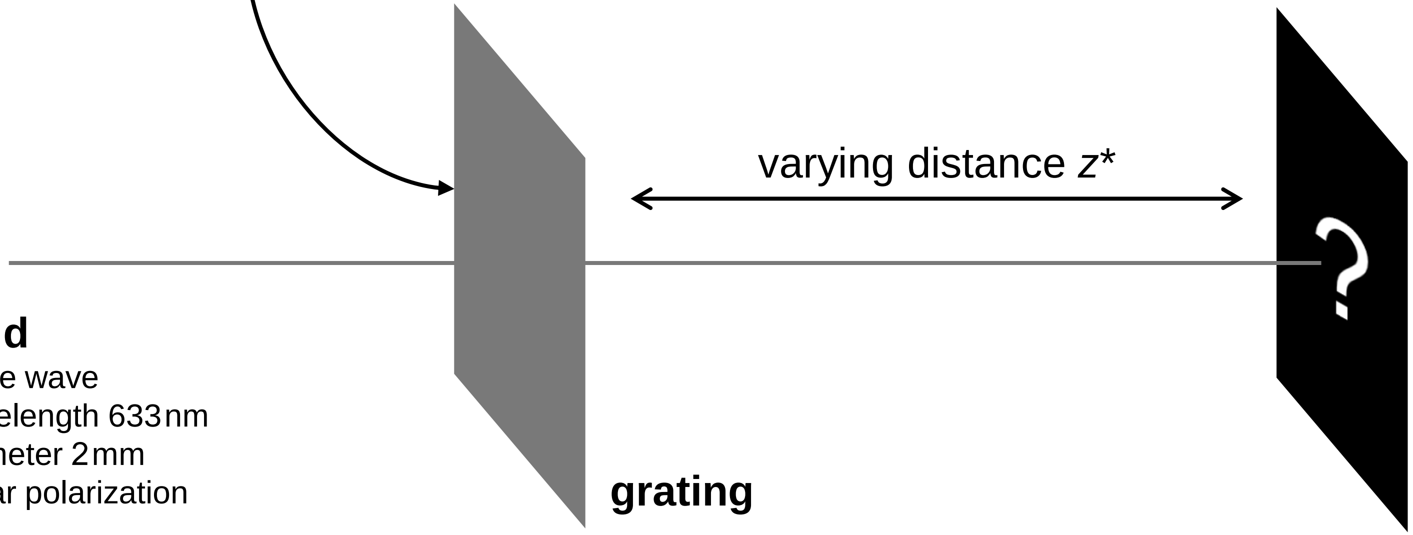
Modeling Task

linear grating
- period 50 µm
- amplitude modulation
- fill factor 20 %



crossed grating
- period 50 × 50 µm
- amplitude modulation
- fill factor 20 %

* Distance z is varied between 0 and the Talbot distance $z_T = d^2/\lambda$ where d is the grating period and λ the wavelength of the input field.



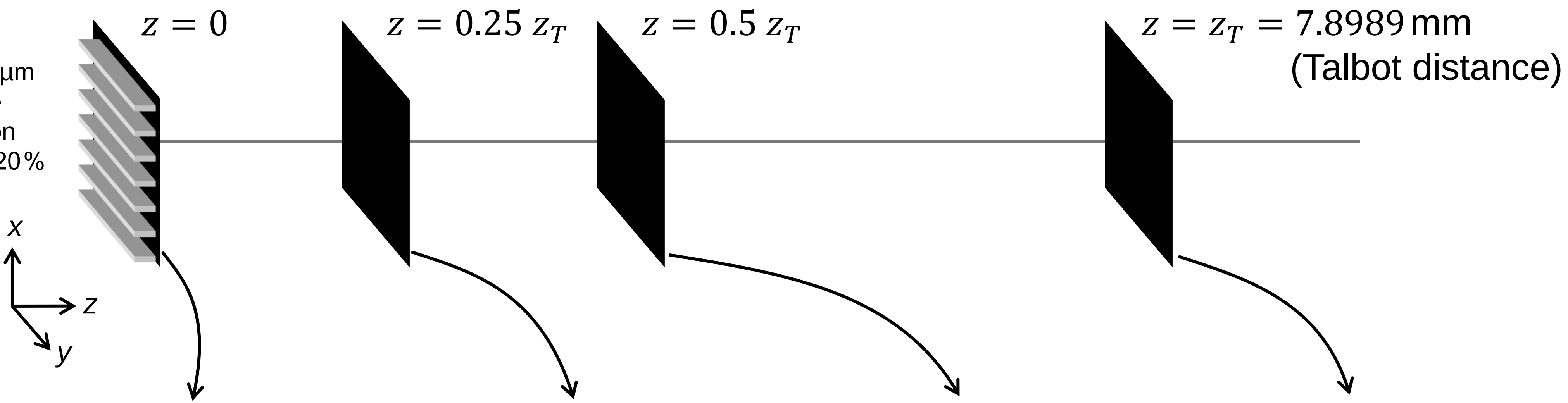
What does the transmitted field behind the grating look like at different distances?

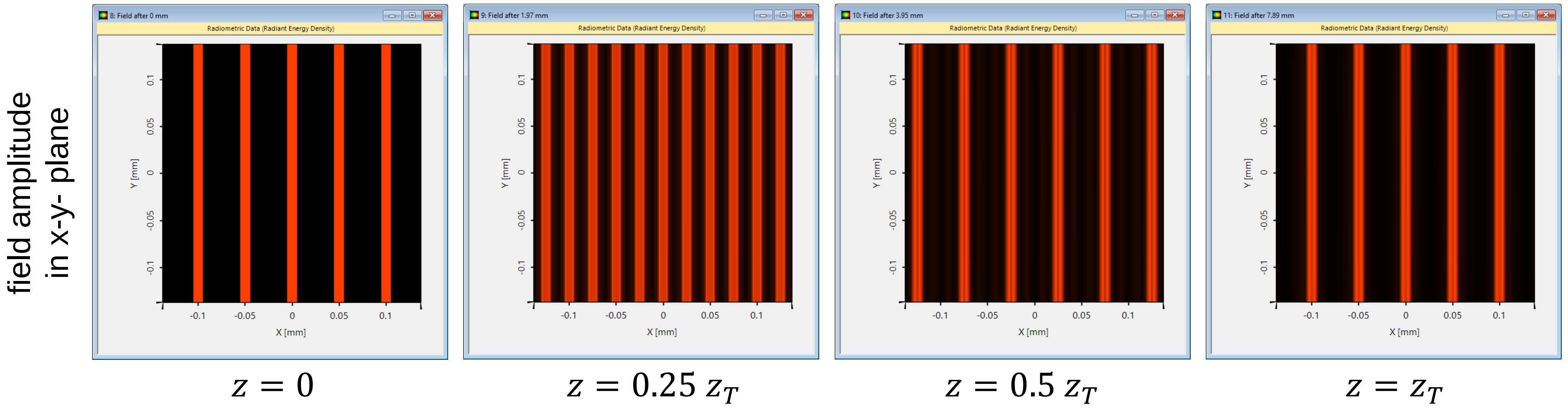
input field
- plane wave
- wavelength 633 nm
- diameter 2 mm
- linear polarization

Field behind Linear Grating

linear grating

- period 50 µm
- amplitude modulation
- fill factor 20 %

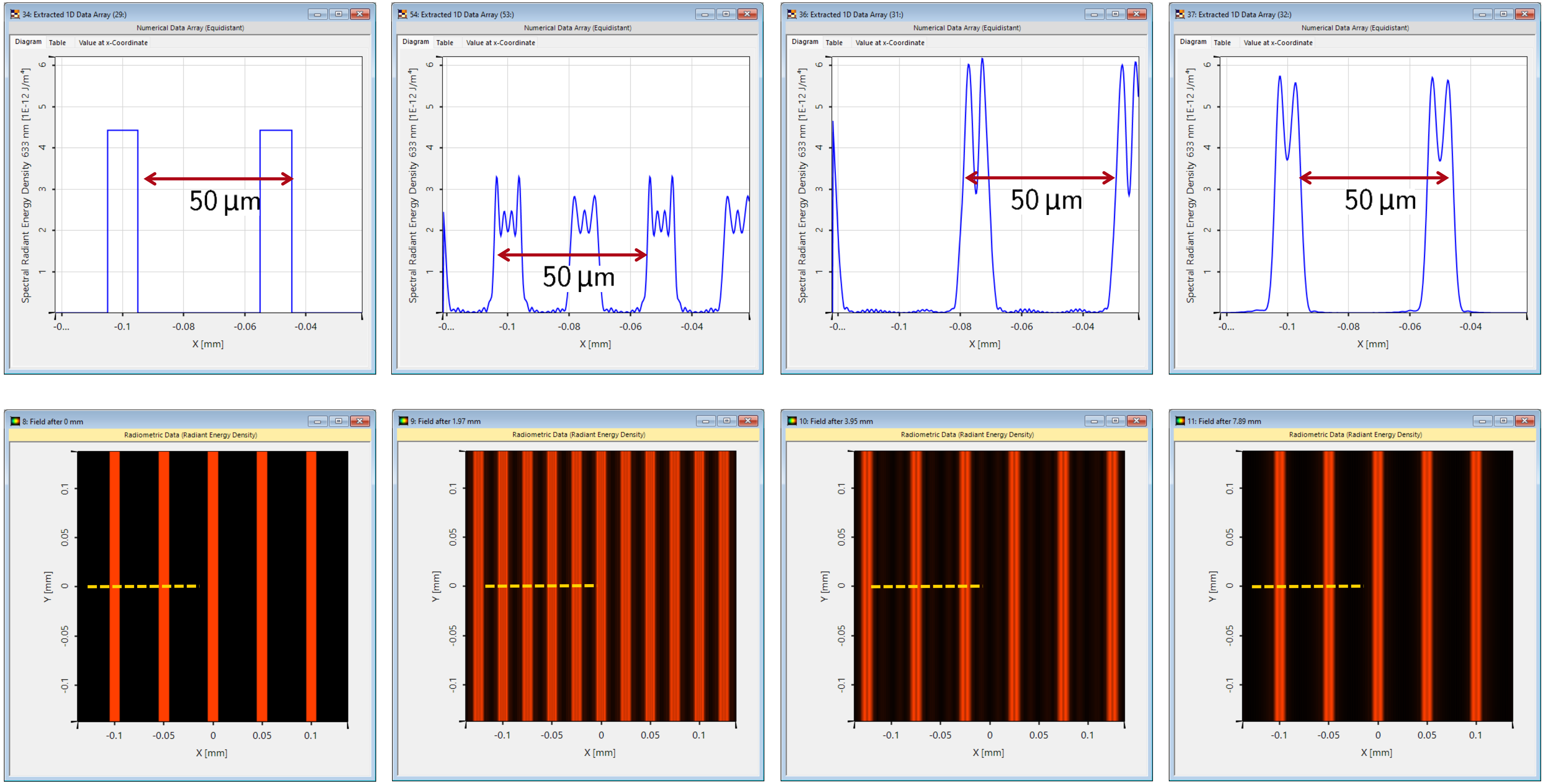




Field behind Linear Grating

field amplitude along x-direction

field amplitude in x-y- plane

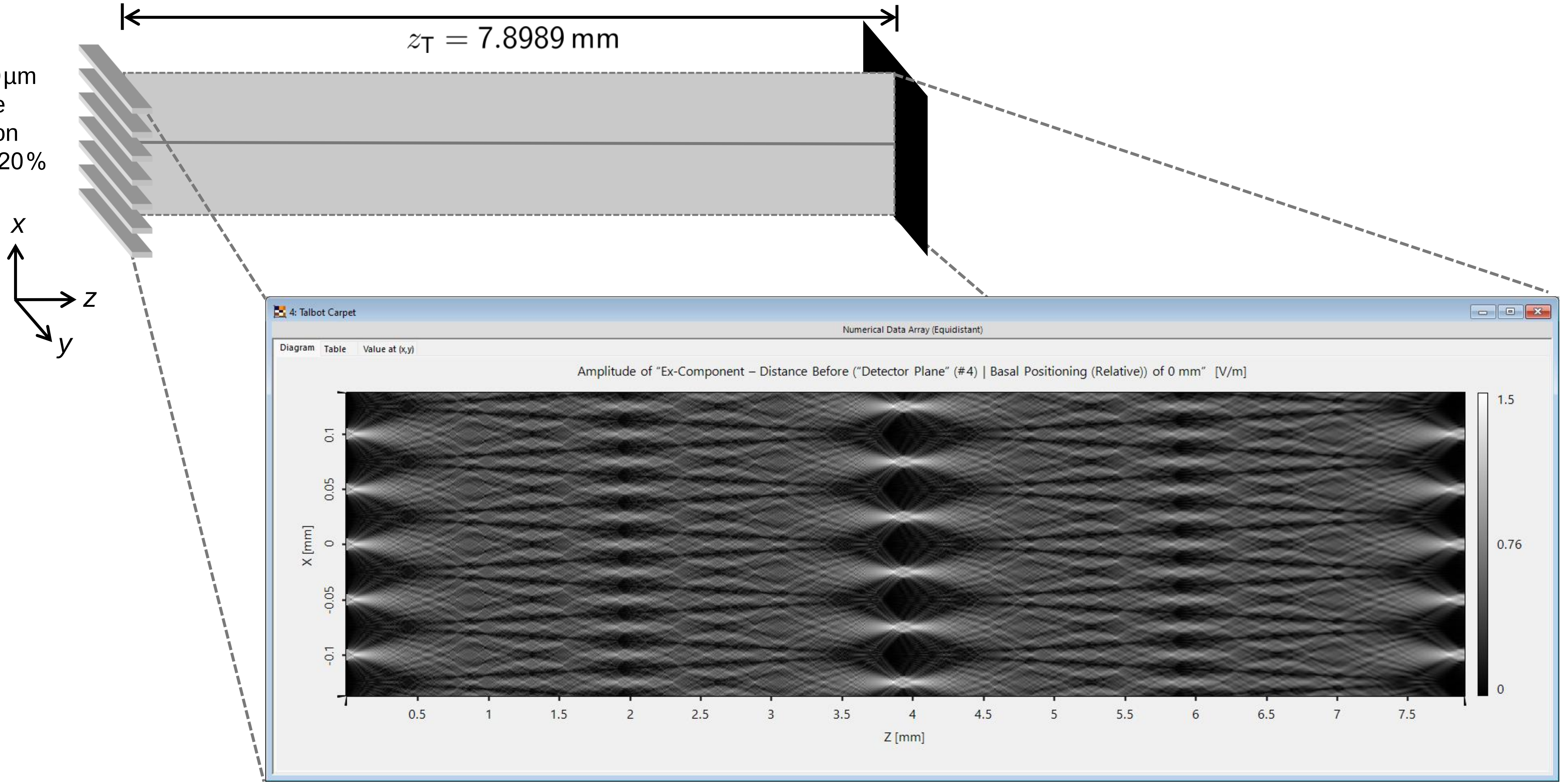


$z = 0$ $\quad$ $z = 0.25\, z_T$ $\quad$ $z = 0.5\, z_T$ $\quad$ $z = z_T$

Field behind Linear Grating – Talbot Carpet

linear grating

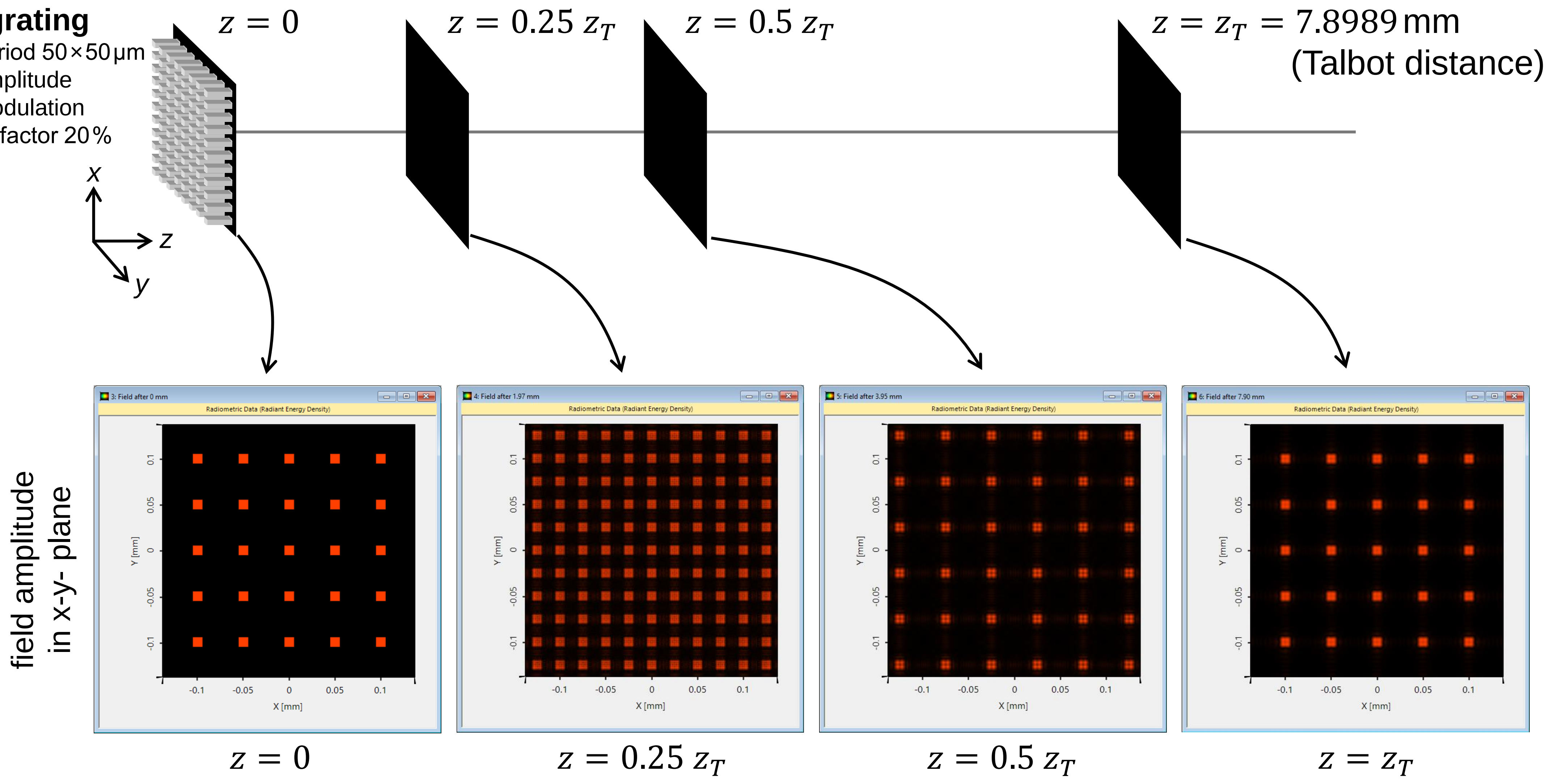
- period 50 µm
- amplitude modulation
- fill factor 20 %



Field behind Crossed Grating

crossed grating

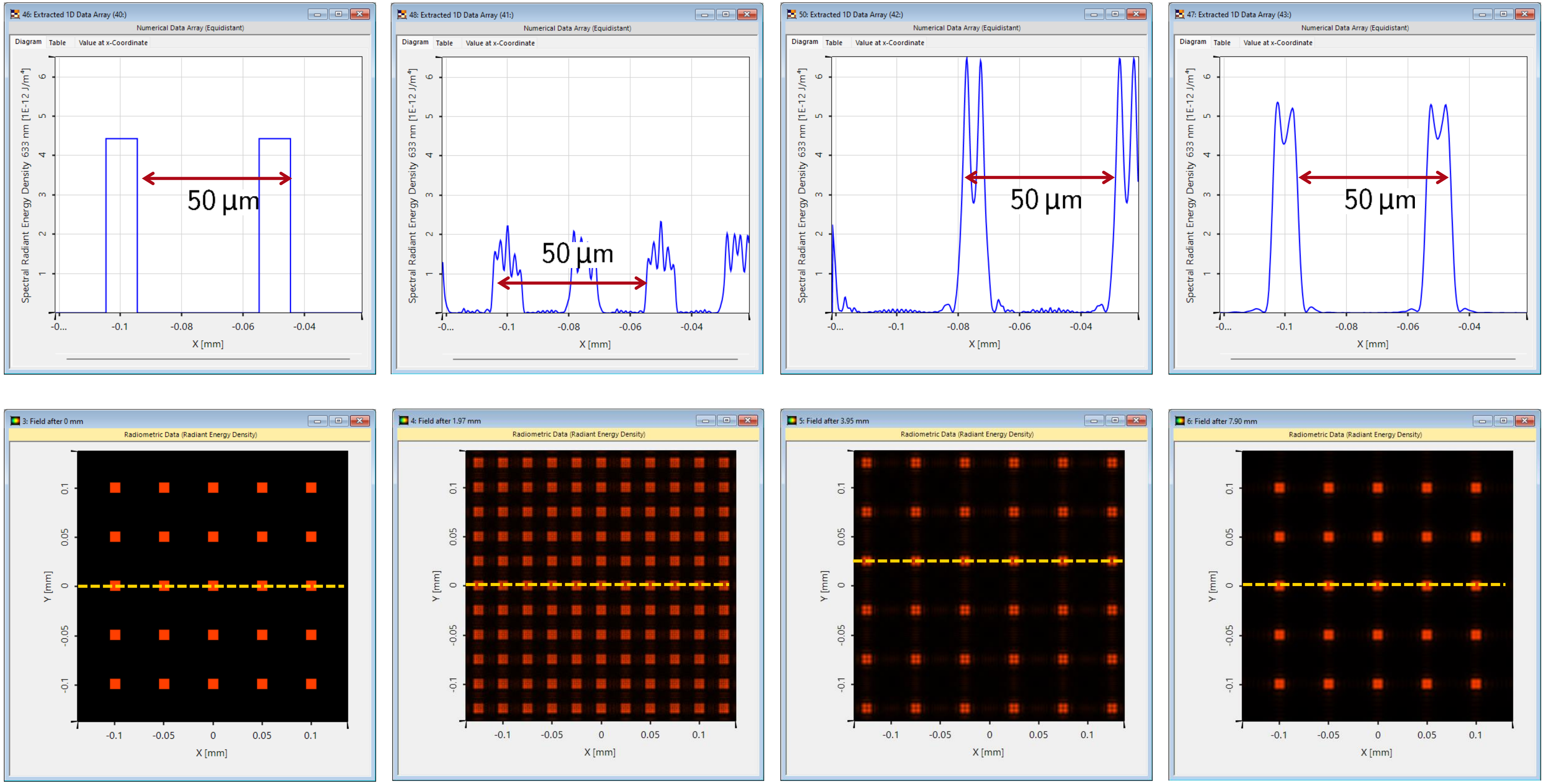
- period 50×50 µm
- amplitude modulation
- fill factor 20 %



Field behind Crossed Grating

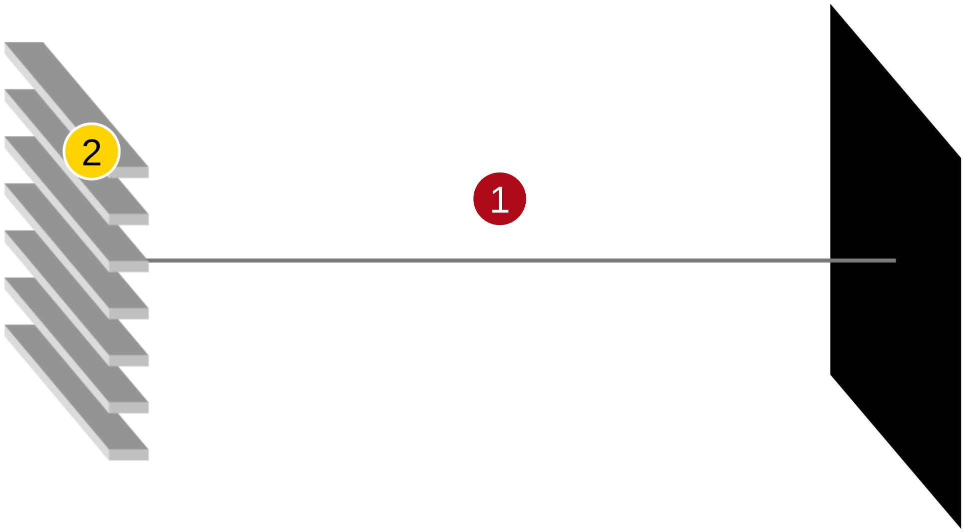
field amplitude along x-direction

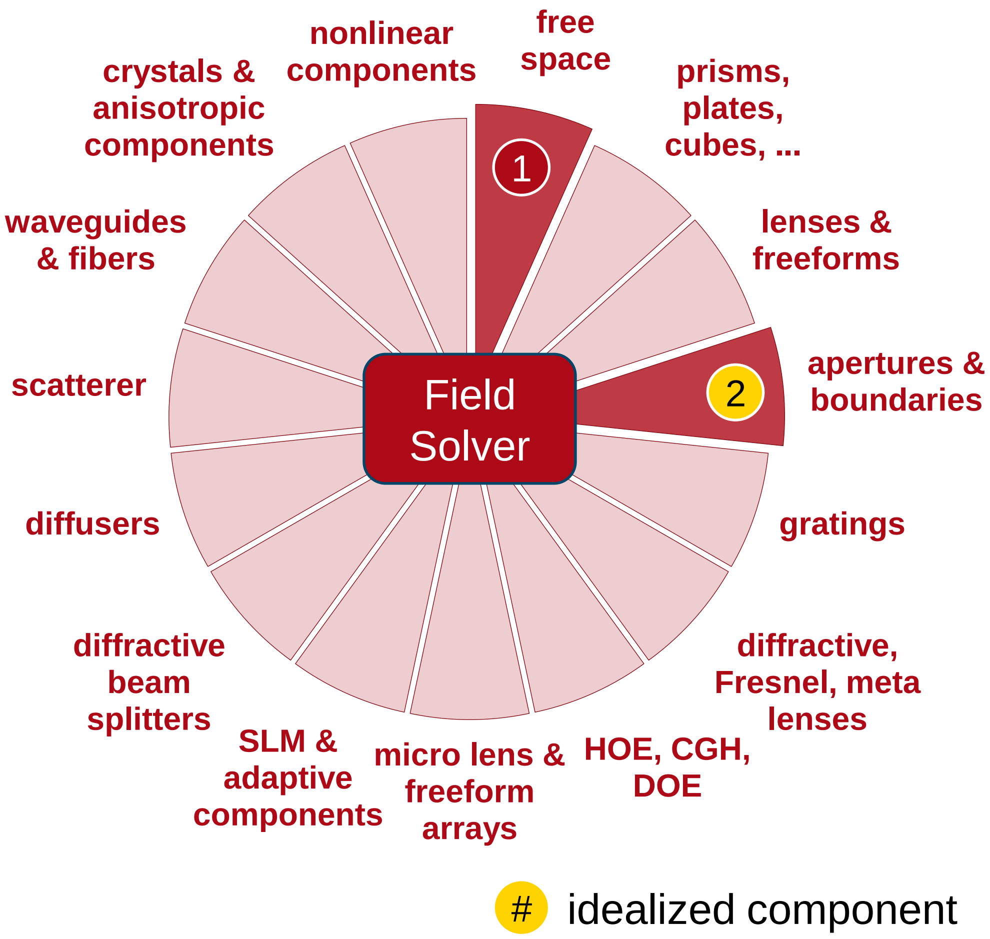
field amplitude in x-y- plane



$z = 0$ $z = 0.25\ z_T$ $z = 0.5\ z_T$ $z = z_T$

VirtualLab Fusion Technologies





Document Information

title	Modeling of the Talbot Effect
document code	MISC.0078
document version	1.2
software edition	VirtualLab Fusion Basic
software version	2023.1 (Build 1.556)
category	Application Use Case
further reading	• Observation of the Poisson Spot • Automatic Selection of Fourier Transform Techniques in Free-Space Propagation Operator • Advanced PSF & MTF Calculation for System with Rectangular Aperture • Talbot Images of A Conical Phase Mask • Configuration of Grating Structures by Using Interfaces • Configuration of Grating Structures by using Special Media