Modeling of the Talbot Effect
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

**Input Field**
- Plane wave
- Wavelength 633 nm
- Diameter 2 mm
- Linear polarization

**Grating**
- Period 50 µm
- Amplitude modulation
- Fill factor 20%

**Crossed Grating**
- Period $50 \times 50$ 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 $\lambda$ the wavelength of the input field.

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

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

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

$z = z_T = 7.8989$ mm (Talbot distance)

Field amplitude in x-y plane

$z = 0$
$z = 0.25 z_T$
$z = 0.5 z_T$
$z = z_T$
Field behind Linear Grating

Field amplitude along x-direction

Field amplitude in x-y plane

$z = 0$  $z = 0.25z_T$  $z = 0.5z_T$  $z = z_T$
Field behind Linear Grating – Talbot Carpet

**Linear Grating**
- Period 50 µm
- Amplitude modulation
- Fill factor 20%

\[ z_T = 7.8989 \text{ mm} \]
Field behind Crossed Grating

crossed grating
• period $50 \times 50 \mu m$
• amplitude modulation
• fill factor 20%

$z = 0$
$z = 0.25 z_T$
$z = 0.5 z_T$
$z = z_T = 7.8989 \text{ mm}$ (Talbot distance)
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

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