

DO.002 (3.0)

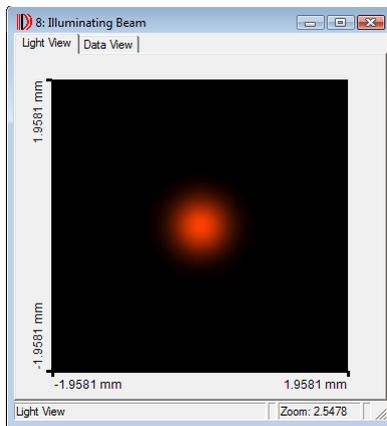
Design & Optimization of Diffractive Light Diffuser for Top Hat Generation

This application scenario demonstrates the design and optimization of a diffractive optical element (DOE) as light diffuser for the generation of a rectangular top hat pattern.

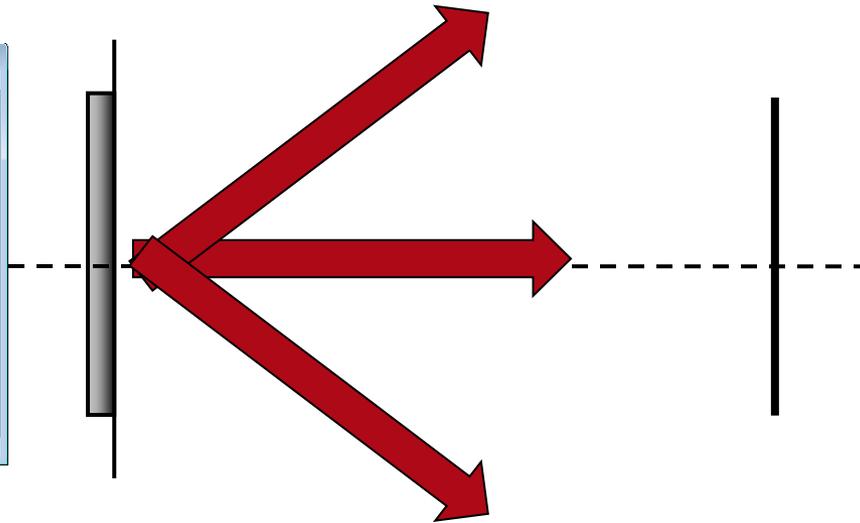
Modeling Task

DOE: Diffuser
Diameter: 1.4mm x 1.4mm
Phase Levels: 2
Pixel Size: $>1\mu\text{m}$

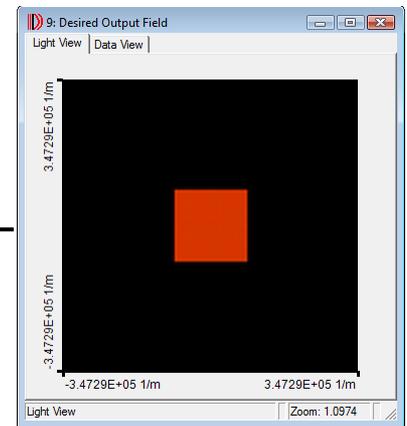
Target
Plane



Illuminating Beam
Intensity

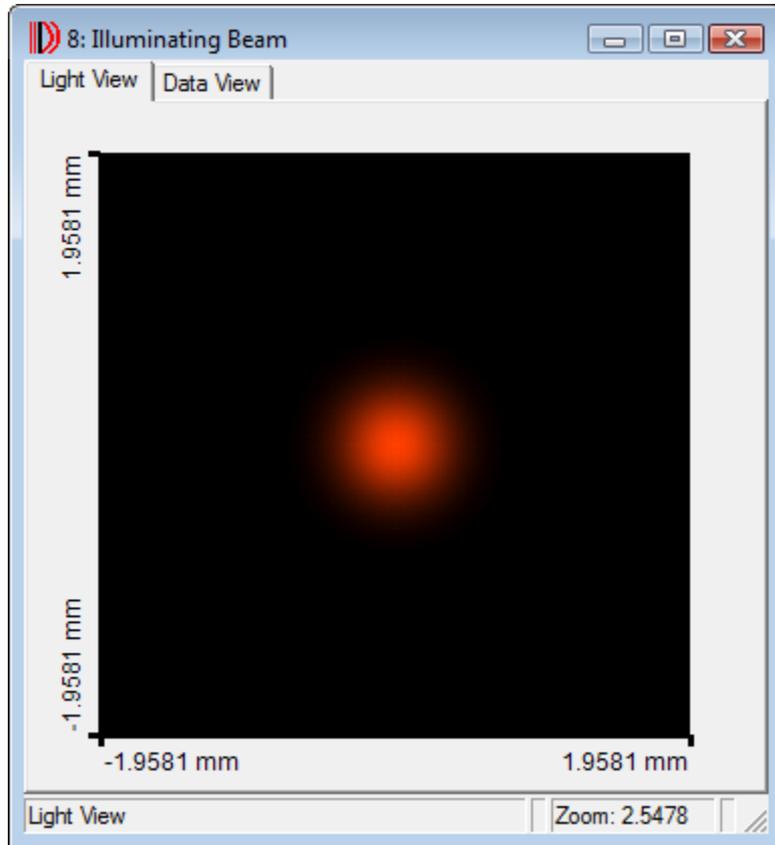


Angular Spectrum Setup



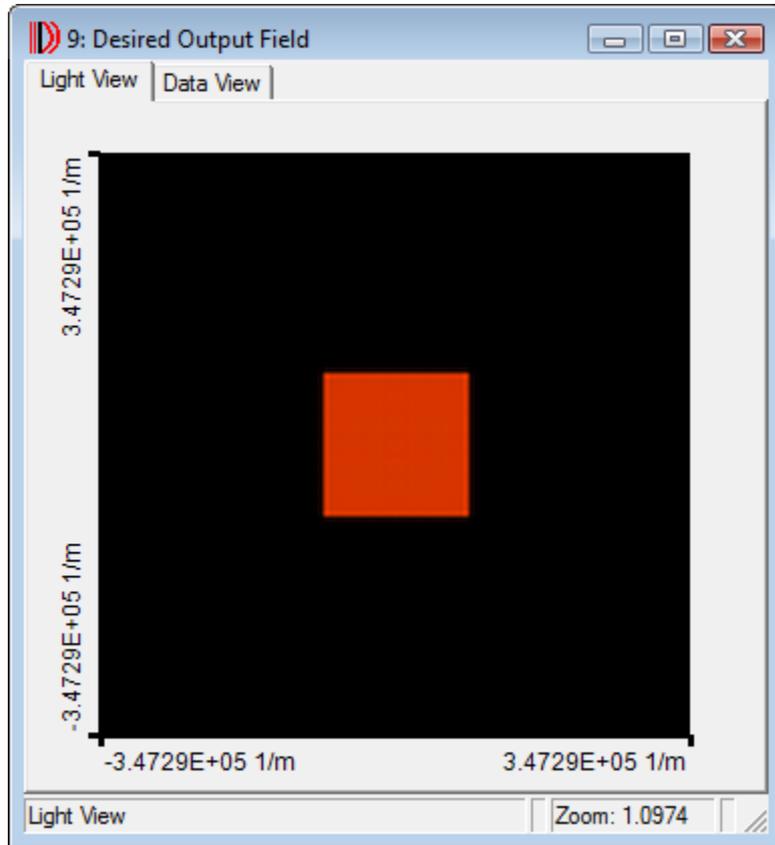
Top Hat Intensity

Illuminating Beam Parameters



- Wavelength: 632.8nm
- Laser Beam Diameter ($1/e^2$): 700 μ m

Desired Output Field Parameters

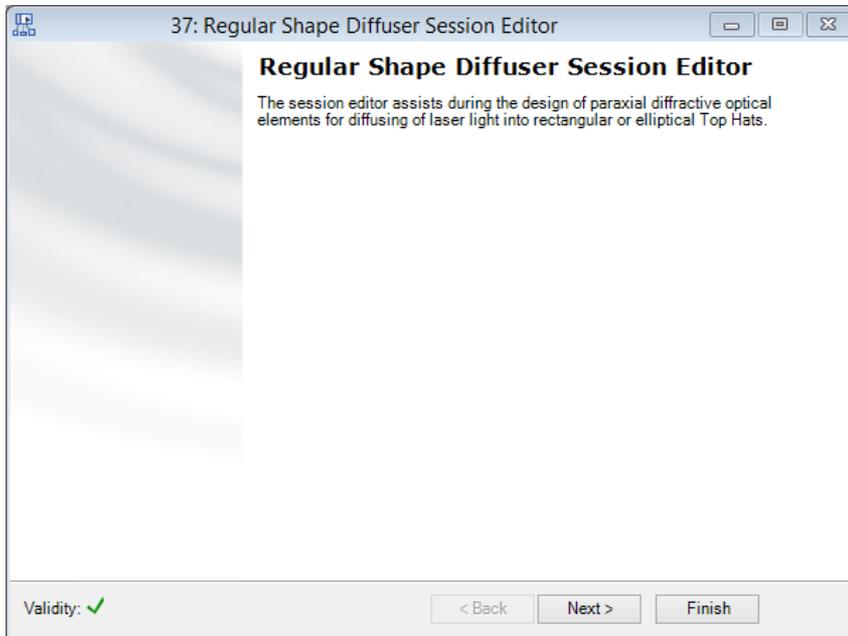


- Diameter: 1°
- Resolution: $\leq 0.03^\circ$
- Efficiency: $>70\%$
- Stray light: $<20\%$

Design & Optimization Approach

- VirtualLab allows different design and optimization approaches.
- For this presented scenario the Iterative Fourier Transformation Algorithm (IFTA) is used for the design and optimization of the desired diffractive optical element (DOE).

Configuration Approach

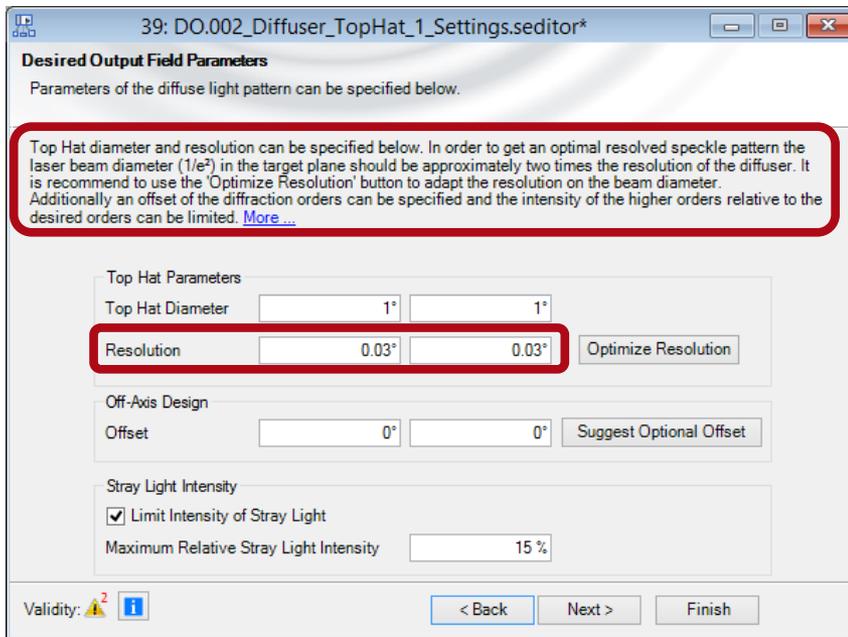


You can either

- use assisting session editors for the setup of the optical system and the configuration of the optimization and design documents
- or configure everything manually (more advanced).

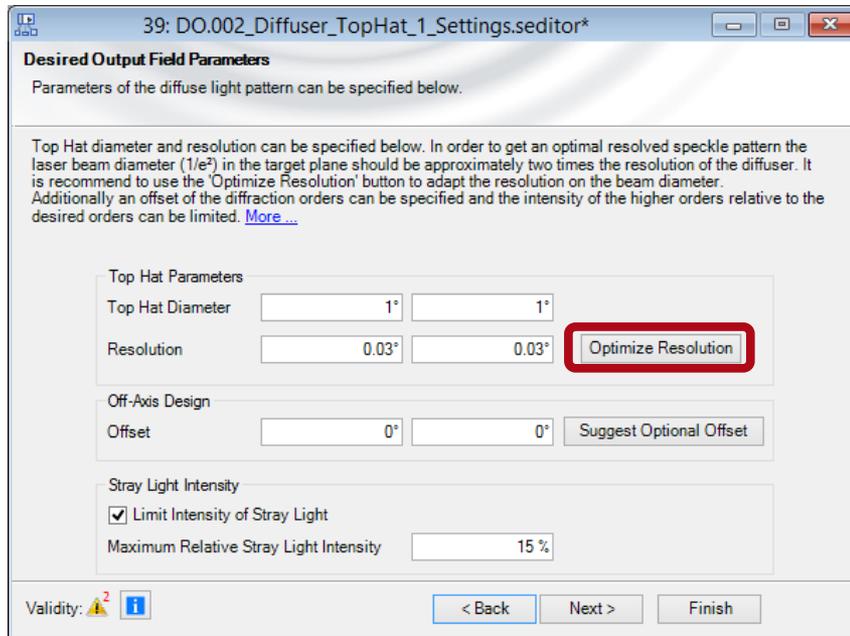
Adjacent you see the session editor's start page. This dialog is accessed via *Start* ribbon > *Diffractive Optics* > *Regular Shape Diffuser*.

Hints during the Specification Procedure



- Specify the desired optical resolution of the light pattern to be created.
- VirtualLab gives some helpful advices.
- Take into account that the light pattern consists of speckles in case of coherent illumination. In order to clearly resolve the desired pattern the speckles should be smaller than the smallest details of the light pattern.
- The speckle sizes are influenced by the set resolution, but cannot be arbitrarily controlled.

Warnings

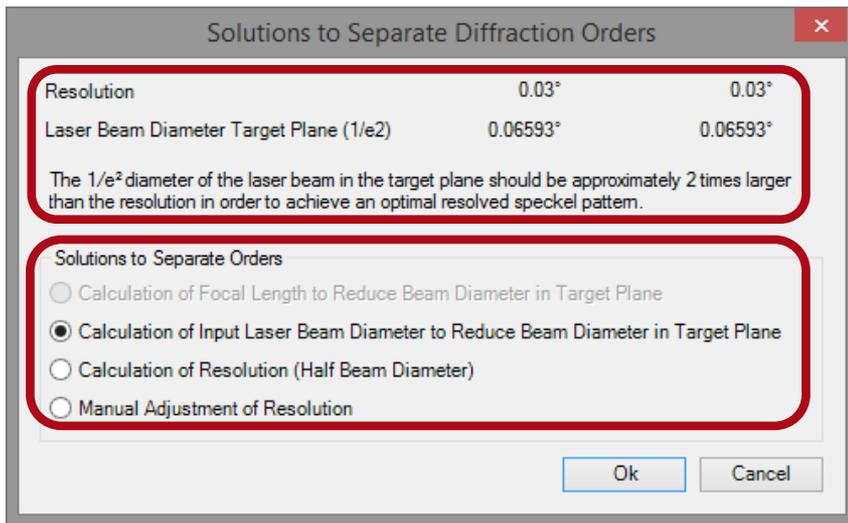


Red warning messages will appear if:

- Desired resolution can't be reached by the specified optical system.
- The optical system will create discrete spots instead of a speckle pattern.
- Not all details of the desired light pattern can be resolved by optical system or the specified resolution.

Click the Optimize Resolution button to get help to adjust system parameters.

Help for Parameter Changes



- This dialog shows if the resolution is suitable for typical diffuser designs.
- Here everything is fine.
- Additionally via this tool VirtualLab offers certain options for parameter adjustments to achieve an optimal ratio of laser beam diameter and resolution.

DOE Transmission Parameters

1: DO.002_Diffuser_TopHat_1_Settings.seditor*

Diffraction Optical Element Period, Pixel Size and Number of Pixels

The required period diameter, pixel size and number of pixel per period are displayed on this page.

Virtuallab calculates from the specifications of the desired output intensity period, pixel size and number of pixels of the diffractive optical element. In order to take into account fabrication constraints a minimum pixel size and pixel size increment can be defined. [More ...](#)

Pixel Size
 Automatic Setting of Pixel Size Manual Setting of Pixel Size

Pixel Size Increment: 10 nm
Minimum Pixel Size: 1 μm

Pixel Size: 9.08 μm 9.08 μm

Transmission Consists of Rectangular Pixels

Period: 1.2076 mm 1.2076 mm

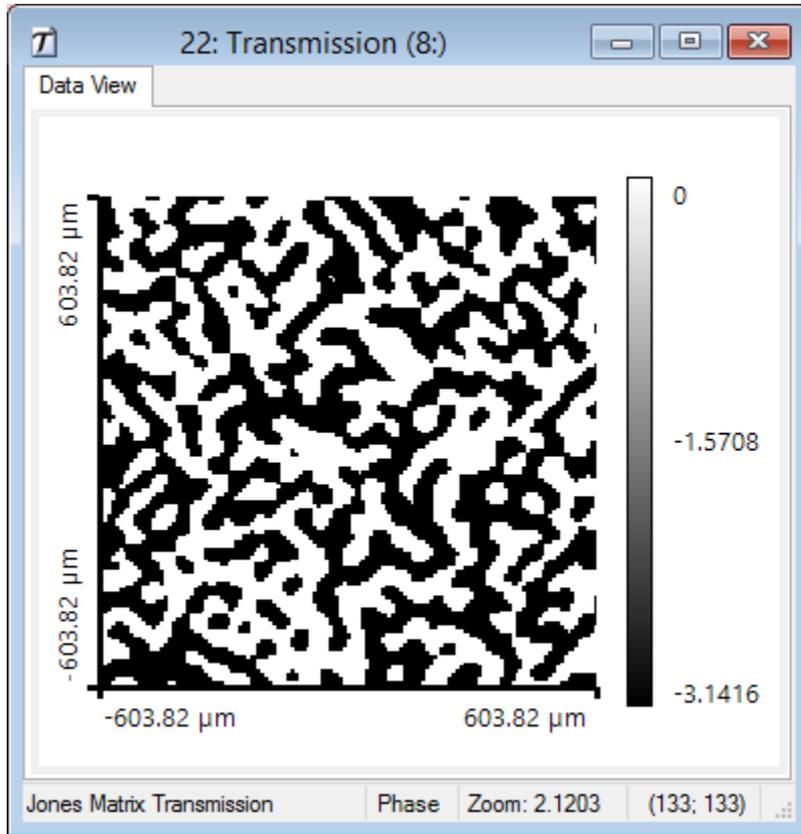
Number of Pixels per Period: 133 133

Validity: 2

< Back Next > Finish

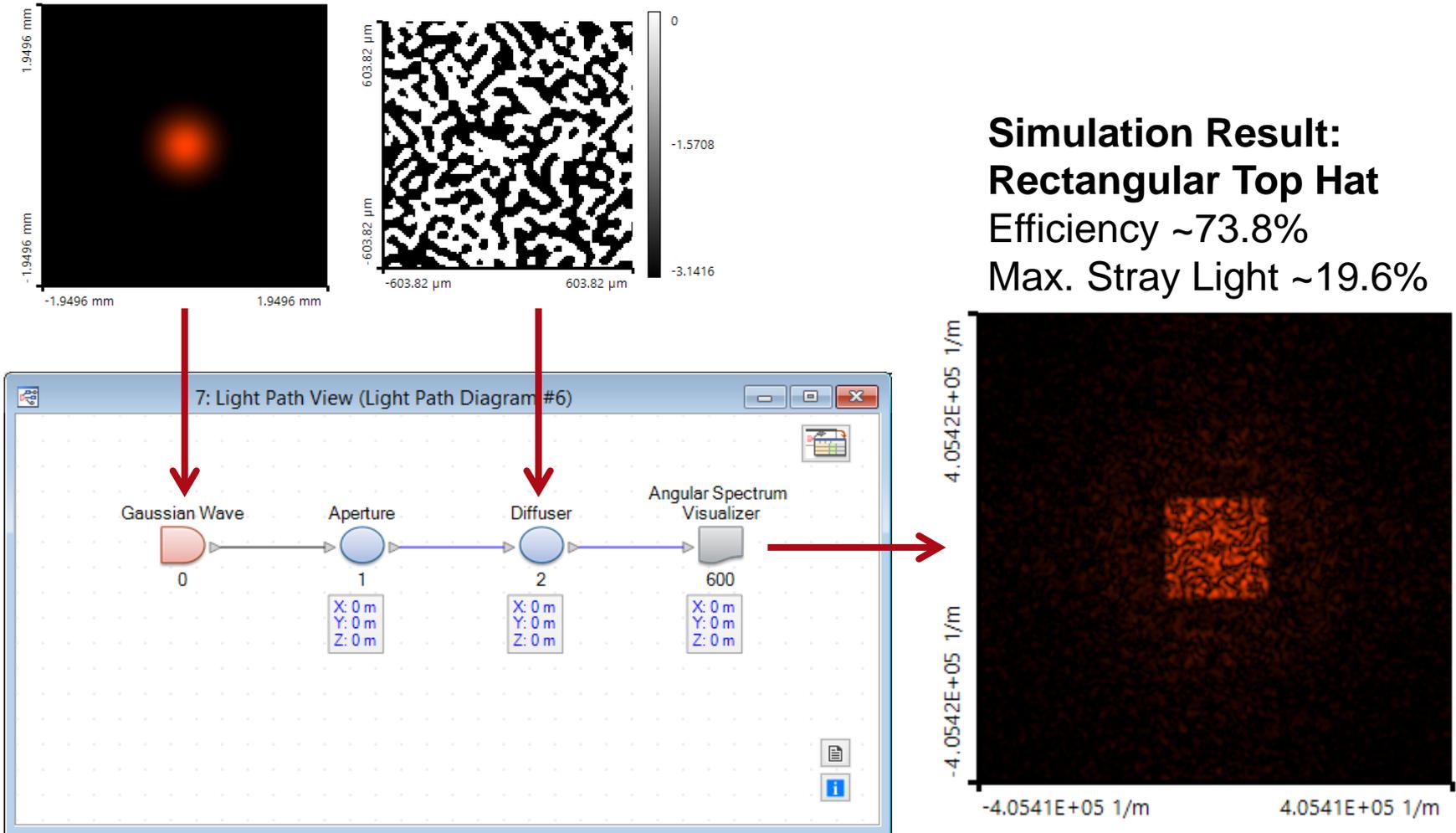
- Pixel size and period of the diffuser transmission are calculated automatically.
- The *Pixel Size Increment* indicates the step size in that the pixel size can be changed by the machine used for fabrication of the diffuser and the positioning accuracy, respectively.
- Expert user may set a user defined pixel size.

Designed & Optimized Diffuser Transmission



- Data View with typical phase distribution (click φ in View ribbon) of optimized transmission.
- Since the optimization of diffractive diffusers starts with random phases the resulting transmission phase differs between different optimizations.

System Analysis with Light Path Diagram (LPD)



Summary

- VirtualLab provides easy to use tools for the design and optimization of diffractive light diffuser elements for generation of regular (diffuse lines or top hats) and arbitrary light patterns.
- Assisted design steps enable also optical engineers inexperienced in diffractive optics to benefit from current developments.