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Design of holographic lenses

Jannik M. Trapp and Toufic G. Jabbour
Corporate Research & Technology, Carl Zeiss AG, Germany
jannik.trapp@zeiss.com

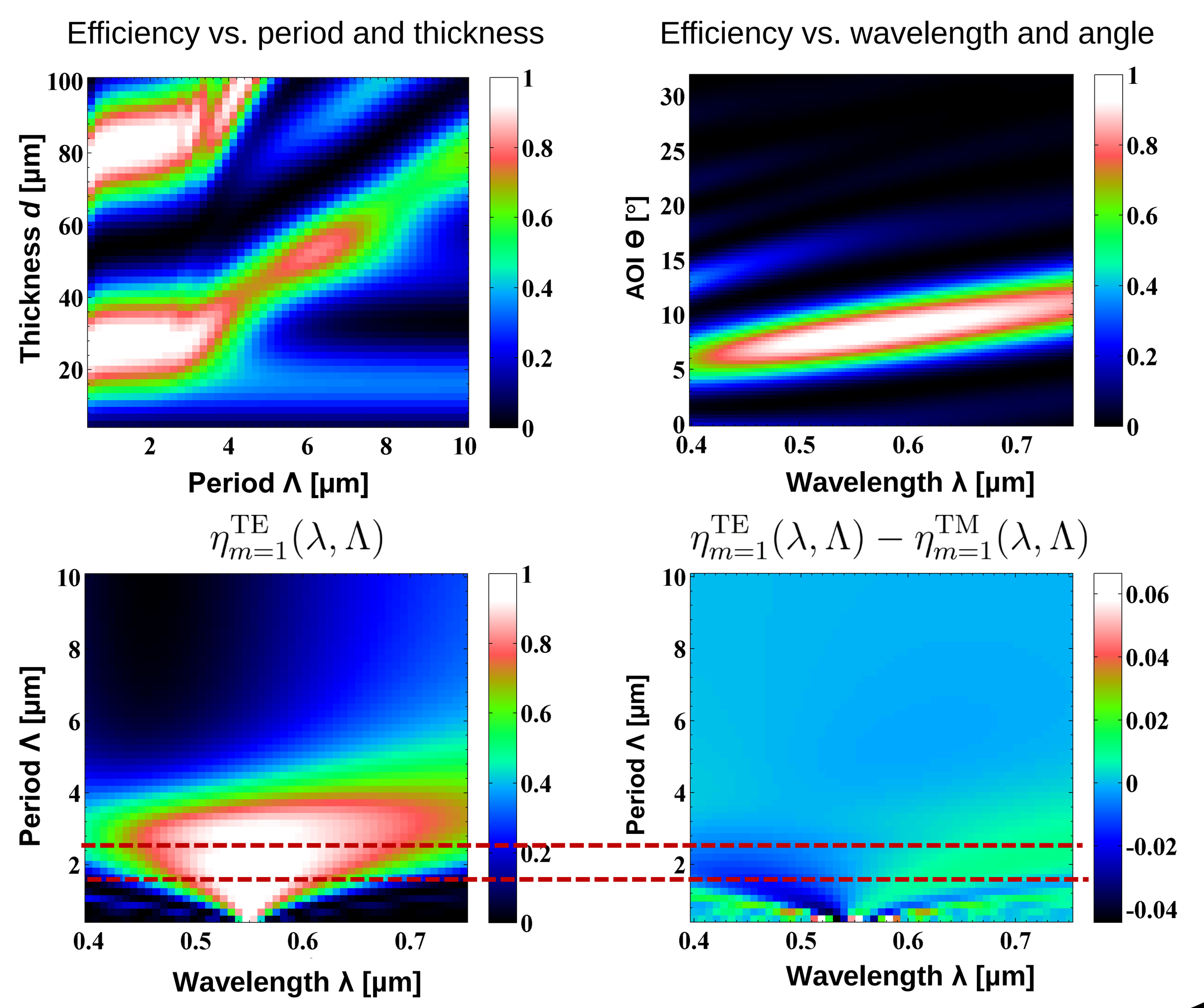
Project Objective

The use of holographic lenses is currently restricted as the angle and wavelength selectivity of holographic gratings results in imaging limitations, especially for polychromatic and large field of view applications. Our goal is to improve holographic lens design to overcome these limitations and enable the use of holographic lenses in novel applications.

Diffraction Efficiency (Transmission Grating)

High diffraction efficiency over the entire visible spectrum is necessary for polychromatic imaging:

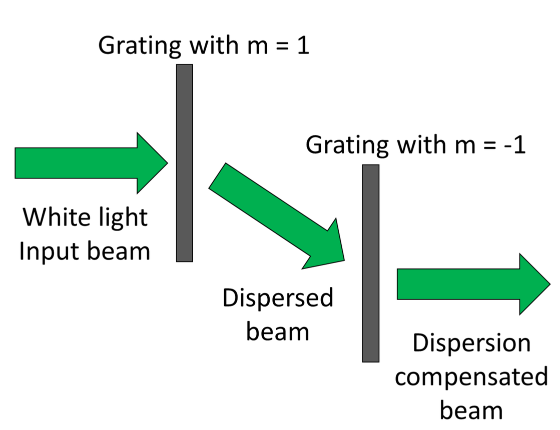
- Diffraction efficiency is a function of: Grating period, grating slant angle, grating thickness, refractive index modulation, input wavelength and incidence direction.
- The figure to the right shows rigorous simulations based on the Fourier Modal Method to optimize grating parameters for imaging application:
    - Top left: two efficiency windows for period and thickness.
    - Top right: broad wavelength bandwidth as a function of angular bandwidth for a fixed parameter choice of period, thickness and index modulation.
- High efficiency without polarization effects can be realized for a grating period range indicated in bottom row figures.

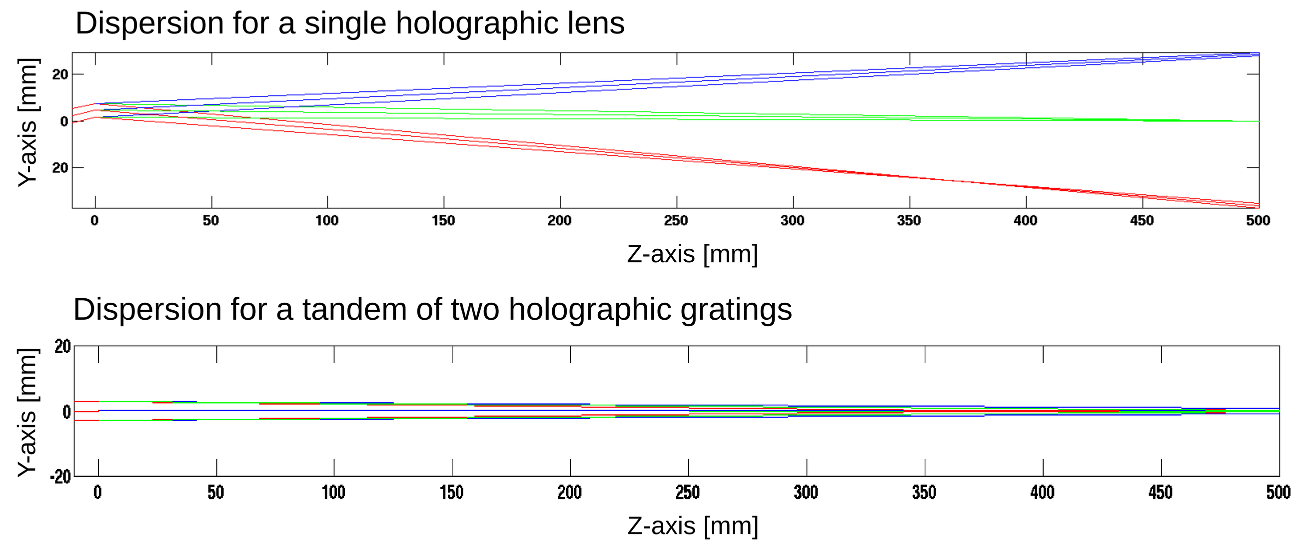


Color Compensation

Grating dispersion occurring in holographic gratings needs to be compensated for polychromatic imaging:

- Transversal dispersion depends on diffraction order and can be cancelled by a tandem of two gratings operating in opposite diffraction order [1].
- Longitudinal dispersion is partially cancelled by the dispersion occurring in human eyes and therefore not thought to be relevant in human vision applications [2].

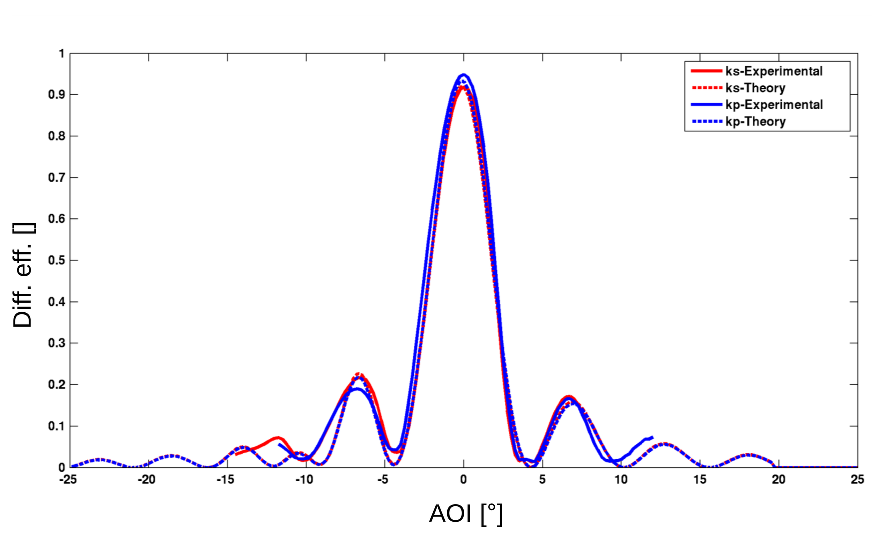


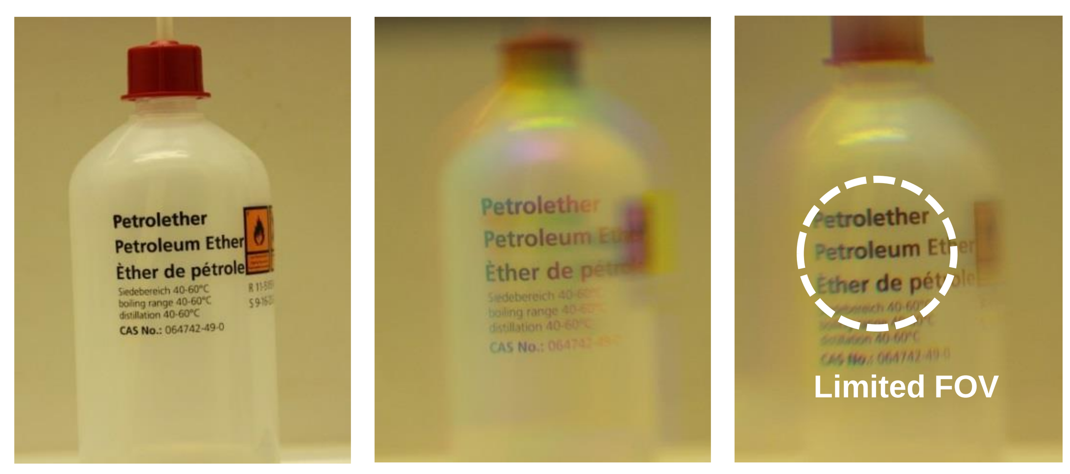


Experimental Results

The described considerations for chromatic images have been used to design and build a holographic lens:

- Experimental diffraction efficiencies (dots) match rigorous simulations (solid lines) for both polarizations (color coded)
- Images obtained with a color corrected lens show good color correction for a limited field of view.





Conclusion and Outlook

So far, we have solved the issues of chromatic imaging with holographic lenses. In future research activities, we want to overcome the angular selectivity of holograms to design holographic lenses with a large field of view.

References

1. Palmer, C.A., *Diffraction Grating Handbook*. 2000: Richardson Grating Laboratory.
2. Gross, H., F. Blechinger, and B. Achtner, *Handbook of Optical Systems, Survey of Optical Instruments*. 2008: Wiley.

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