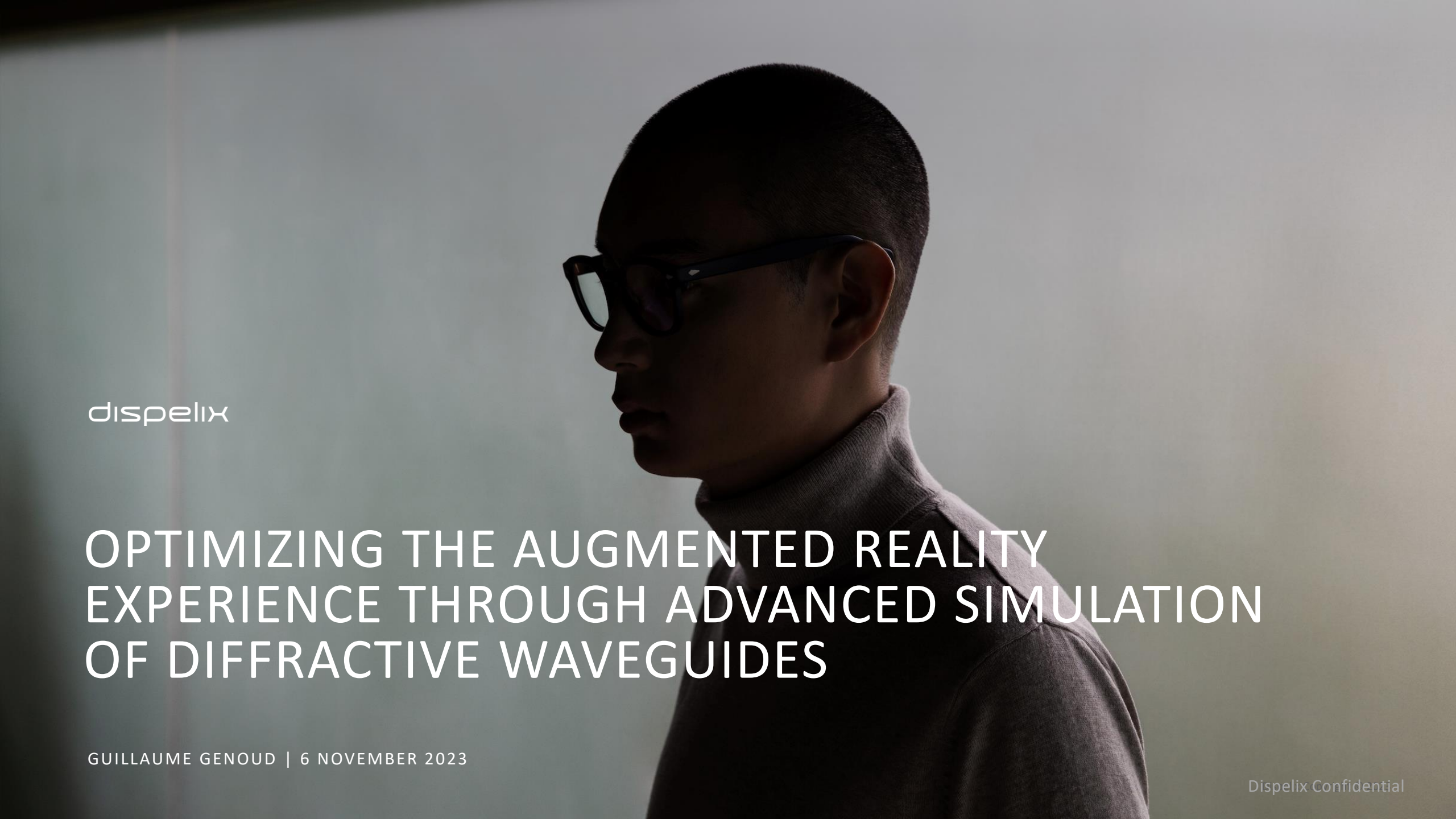


dispelix

OPTIMIZING THE AUGMENTED REALITY EXPERIENCE THROUGH ADVANCED SIMULATION OF DIFFRACTIVE WAVEGUIDES

GUILLAUME GENOUD | 6 NOVEMBER 2023

dispelix

dispelix

Founded 2015

Offices in Finland, US and China

Enabled by 150+ talented employees

150+ patents and 200+ patent applications

dispelix

Waveguides at the core of AR displays

Pioneering R&D

Advanced algorithm development and waveguide design

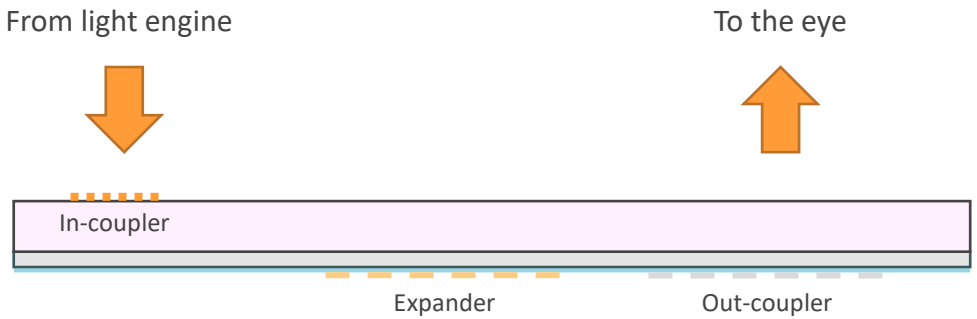
Cutting-edge diffractive surface relief gratings

Novel materials and fabrication methods

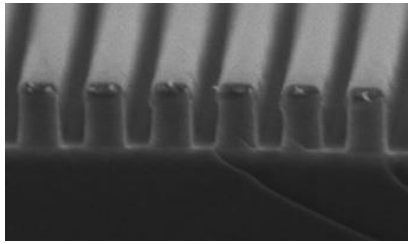
Advanced full-color, single- and multi-layer architectures

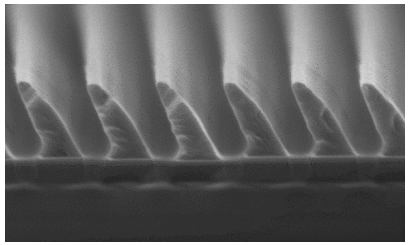
From near-eye to head-up displays

Surface relief gratings

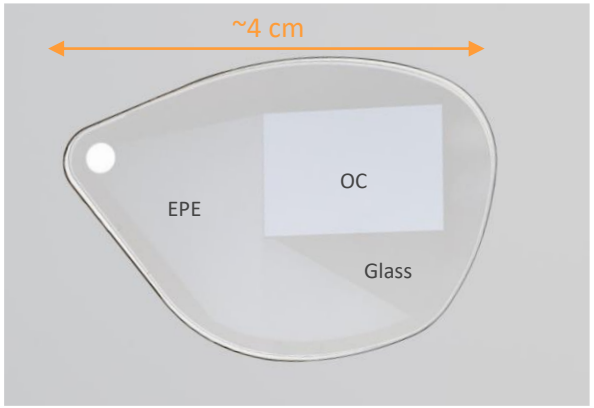


Gratings → nm scale





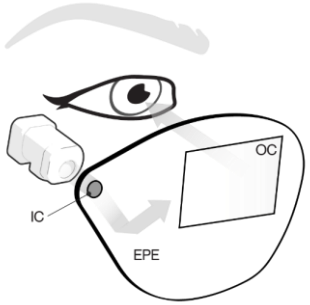
Waveguide → cm scale



Design challenge:
Combine simulation of nano-scale diffractive gratings with macro-scale waveguide dimensions

Optimizing the complete AR experience

INPUTS



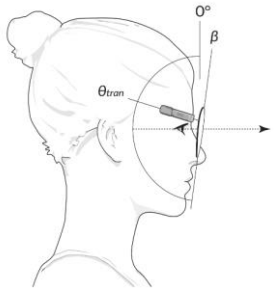
Light engine

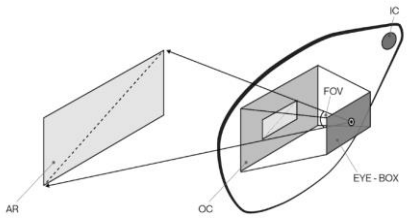
Field of view

Eyebox size

Tilt

Dimensions





OUTPUTS

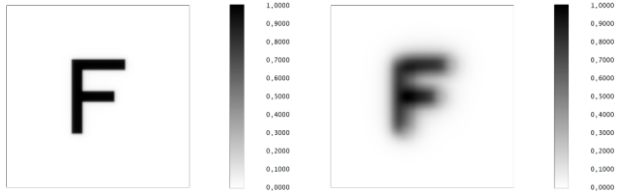
Image brightness

Uniformity

Color

Sharpness

Visual appearance



Sharpness (MTF)

Multi-objective optimization problem for the entire system with convoluted **inter-dependencies**

Unmatched design expertise

Proprietary simulation software with graphical user interface

Merges conventional algorithms and AI features

Design capability for LED and laser waveguide combiners

Simulates critical performance parameters and visual appearance

Waveguide Studio

Linear & double periodic gratings with all possible propagation directions

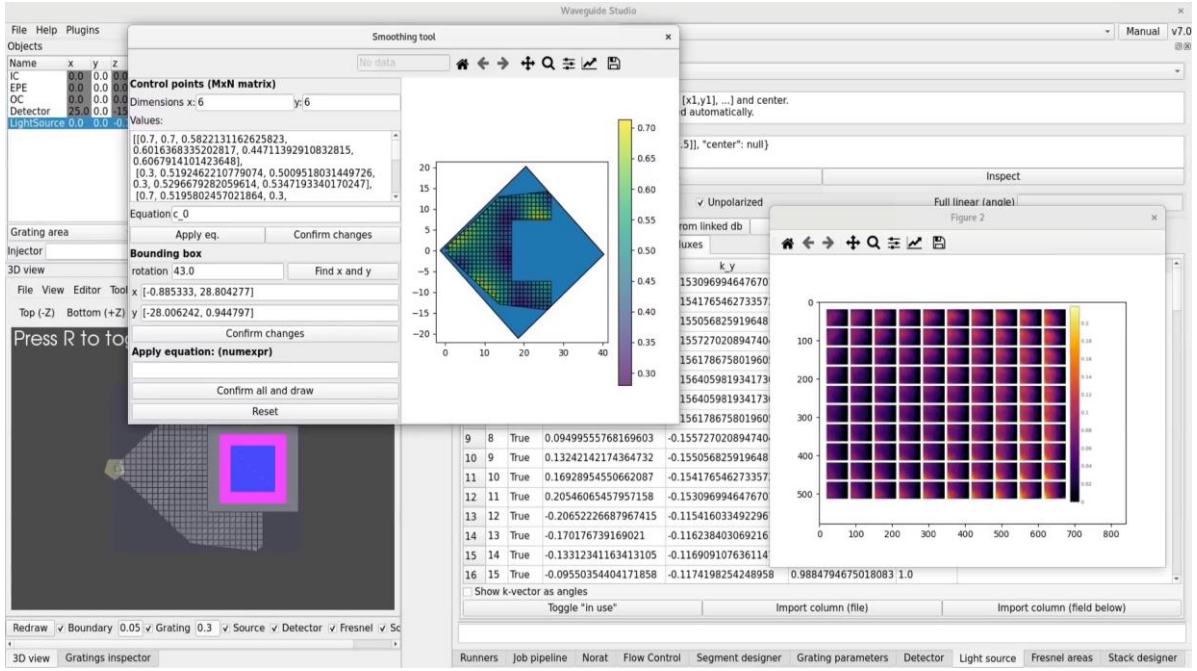
Field propagation with polarization and phase including interference and coherence effects

Arbitrary grating structures, both SRG & VHG

Double sided & multiplate systems with ghost analysis

MTF optimization & tolerancing

Compatible with HPC clusters



Mushroom Forest with Waveguide Studio

300 CPU cores

11 x 11 FOV points

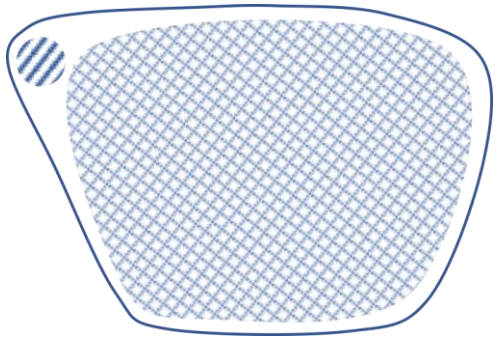
3 wavelengths

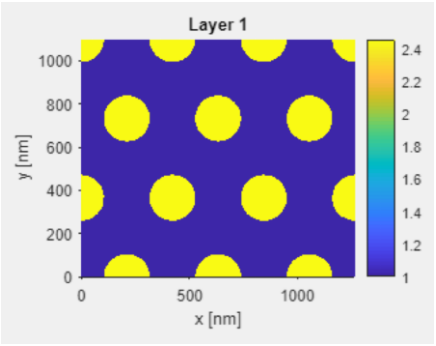
6 propagation directions

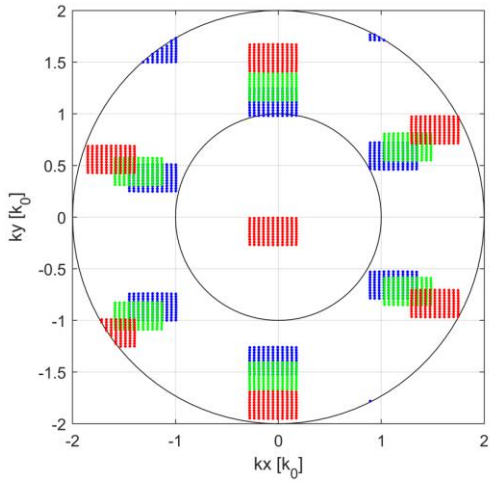
One full simulation ~10 seconds

Ray tracing > 10 hours

Scales linearly with #cores







The Critical Loop

Computing

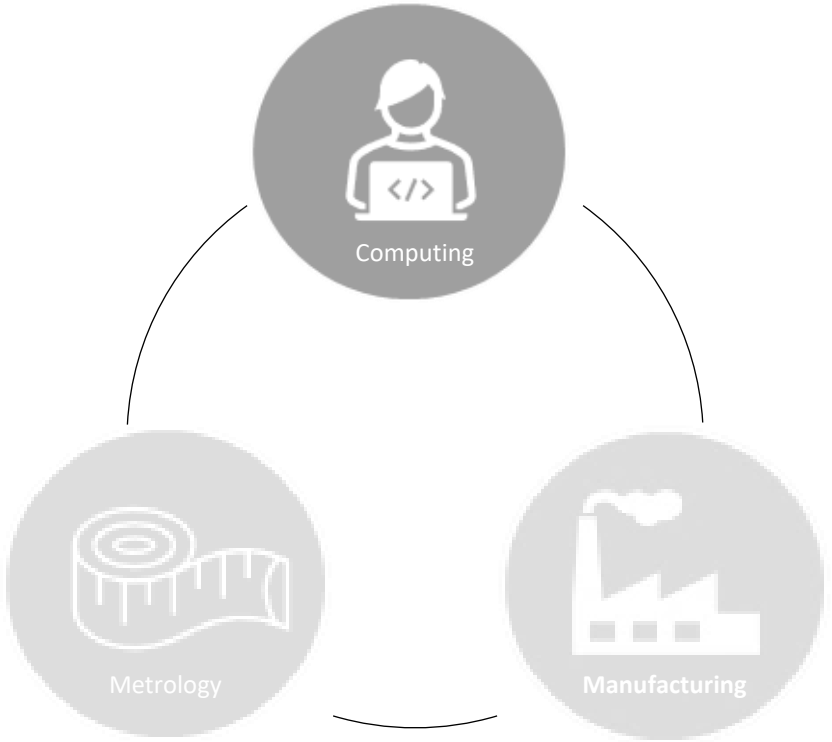
Efficient way to improve and optimize

Manufacturing

From a simulation to the physical sample

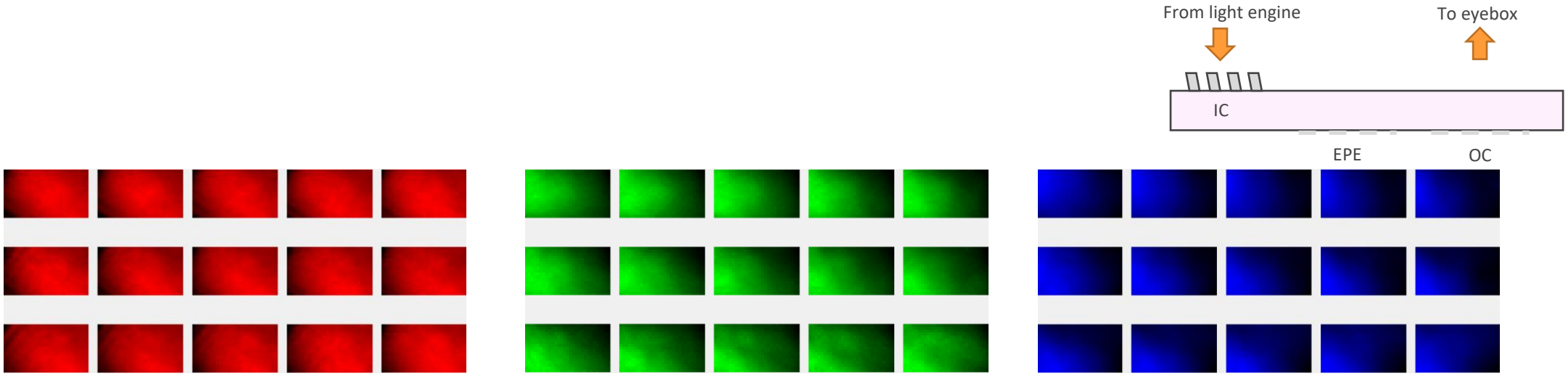
Metrology

To measure the success and to drive the development



Simulated vs. Measured fluxes

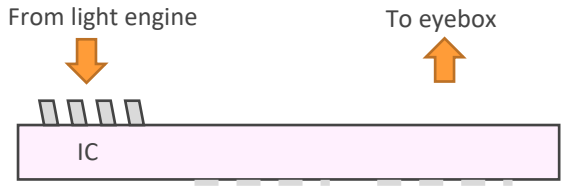
Simulation without phase → no interference artifacts

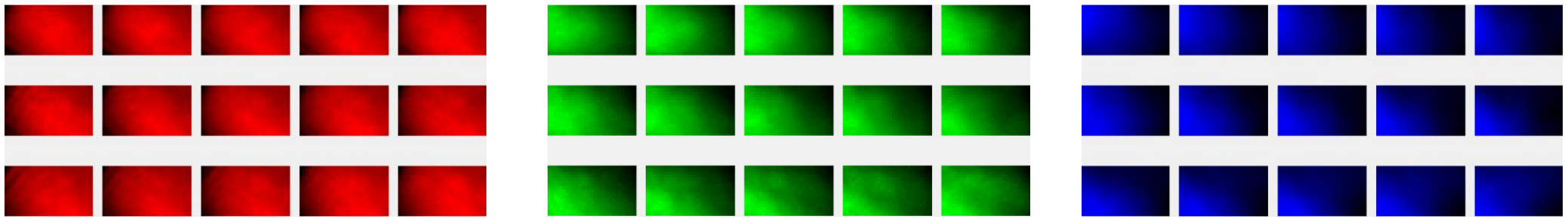


Simulated fluxes for different color channels

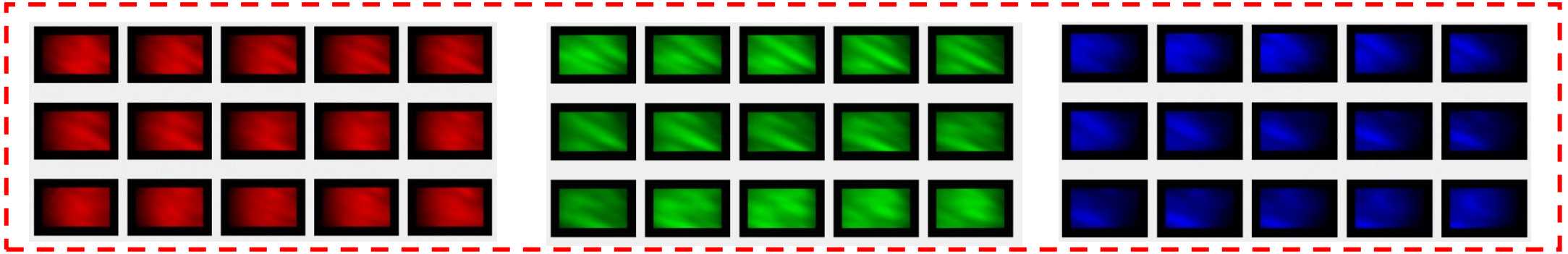
Simulated vs. Measured fluxes

Simulation without phase → no interference artifacts





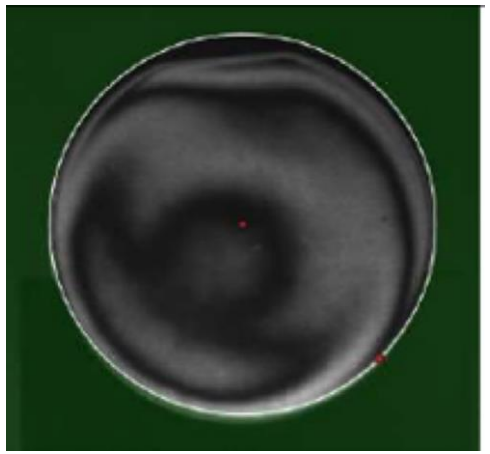
Simulated fluxes for different color channels



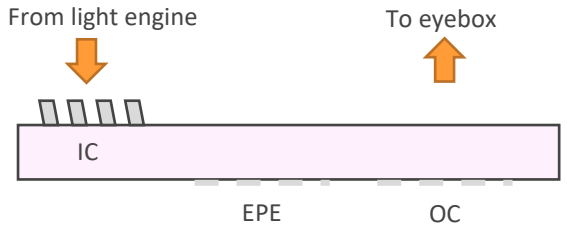
Measured fluxes for different color channels

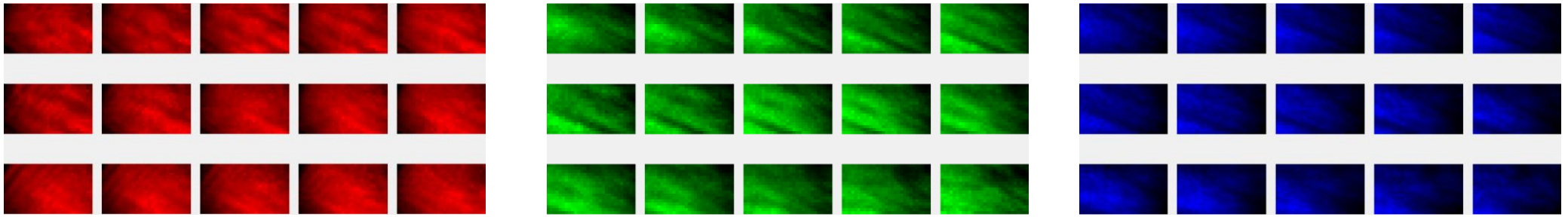
Simulated vs. Measured fluxes

Simulation with phase → interference artifacts

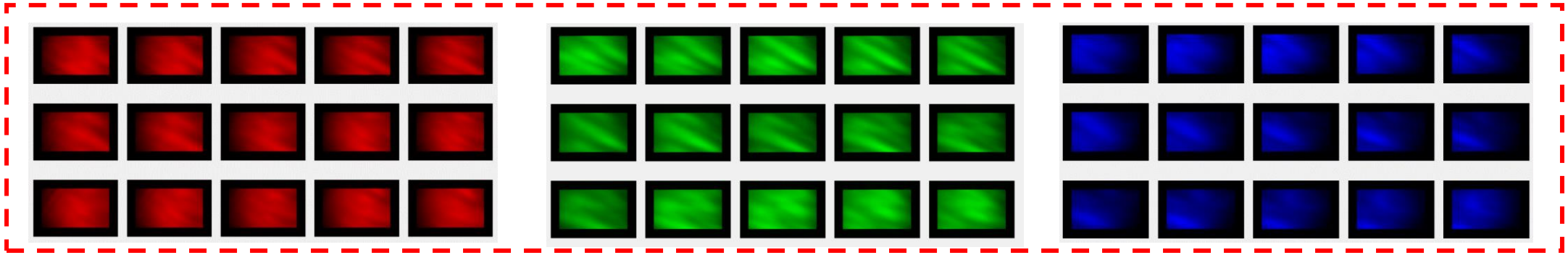


Measured wafer thickness variation





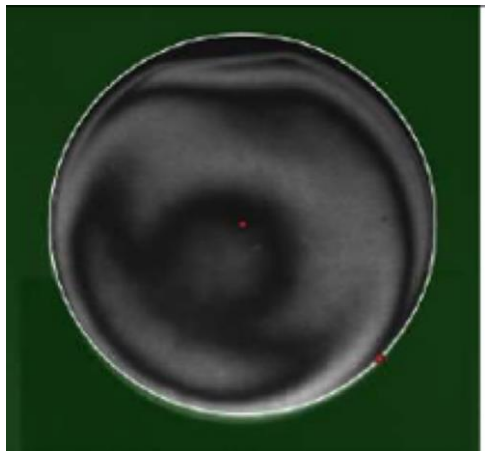
Simulated fluxes for different color channels



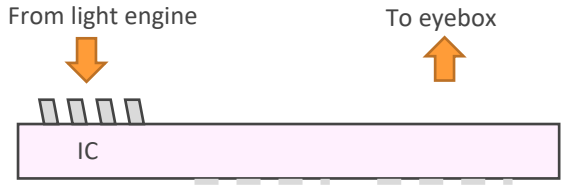
Measured fluxes for different color channels

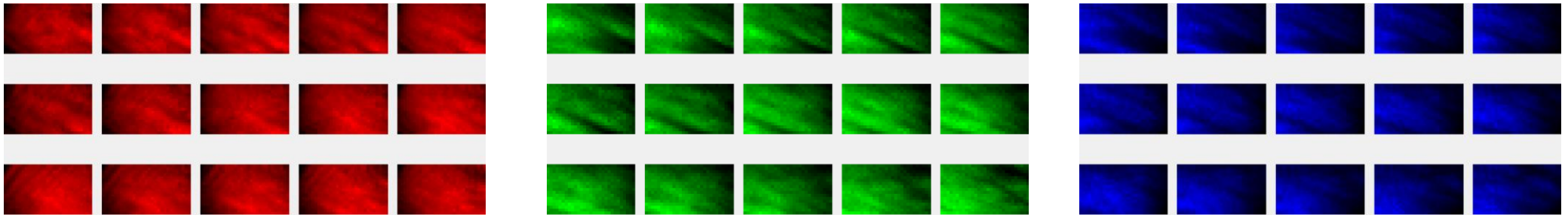
Simulated vs. Measured fluxes

Simulation with phase and wafer thickness variation → interference artifacts

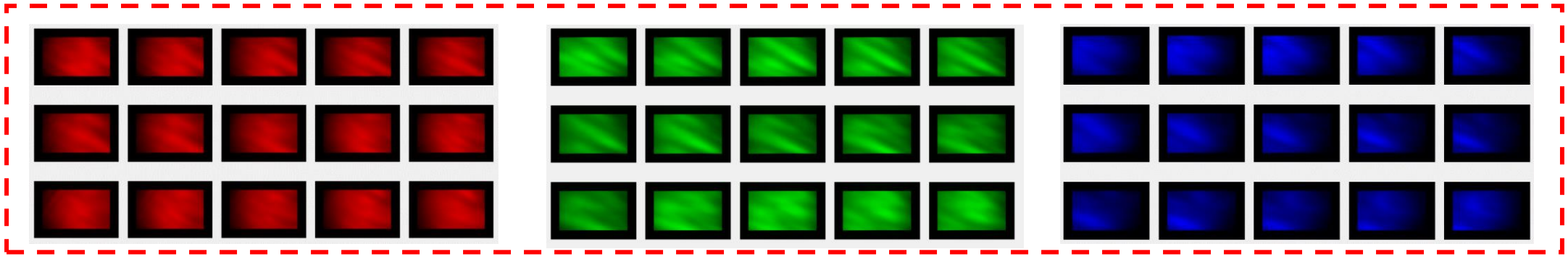


Measured wafer thickness variation



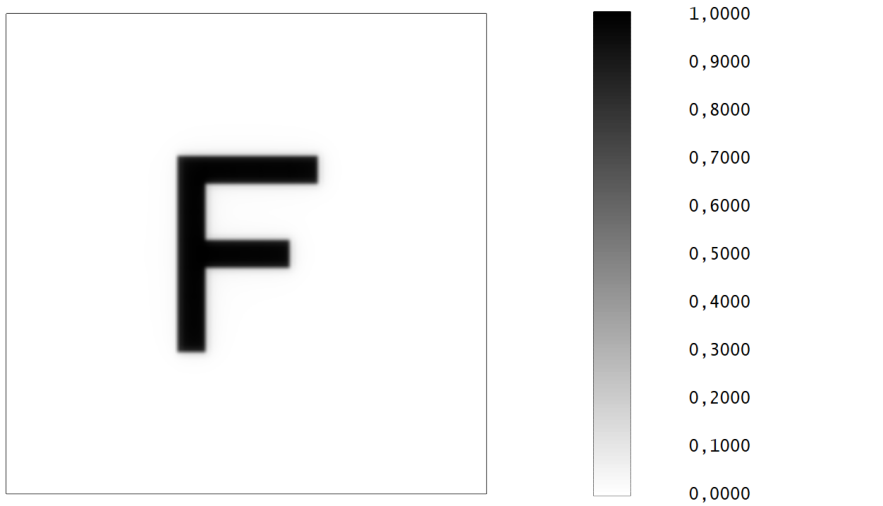


Simulated fluxes for different color channels



Measured fluxes for different color channels

Modulation transfer function (MTF)



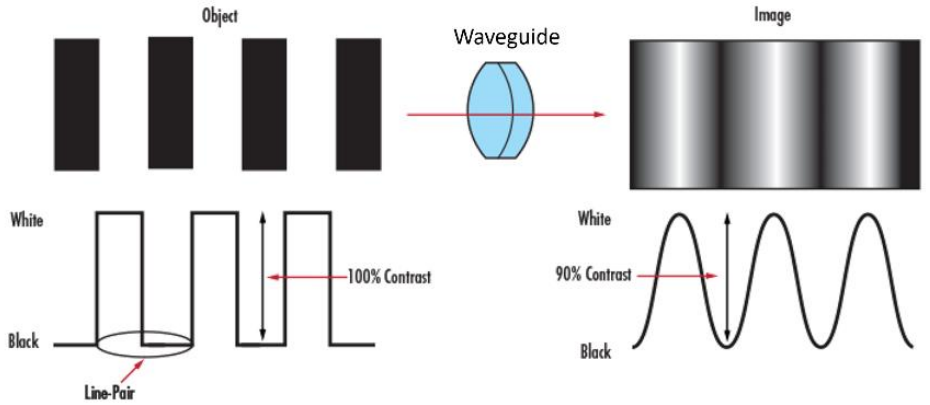
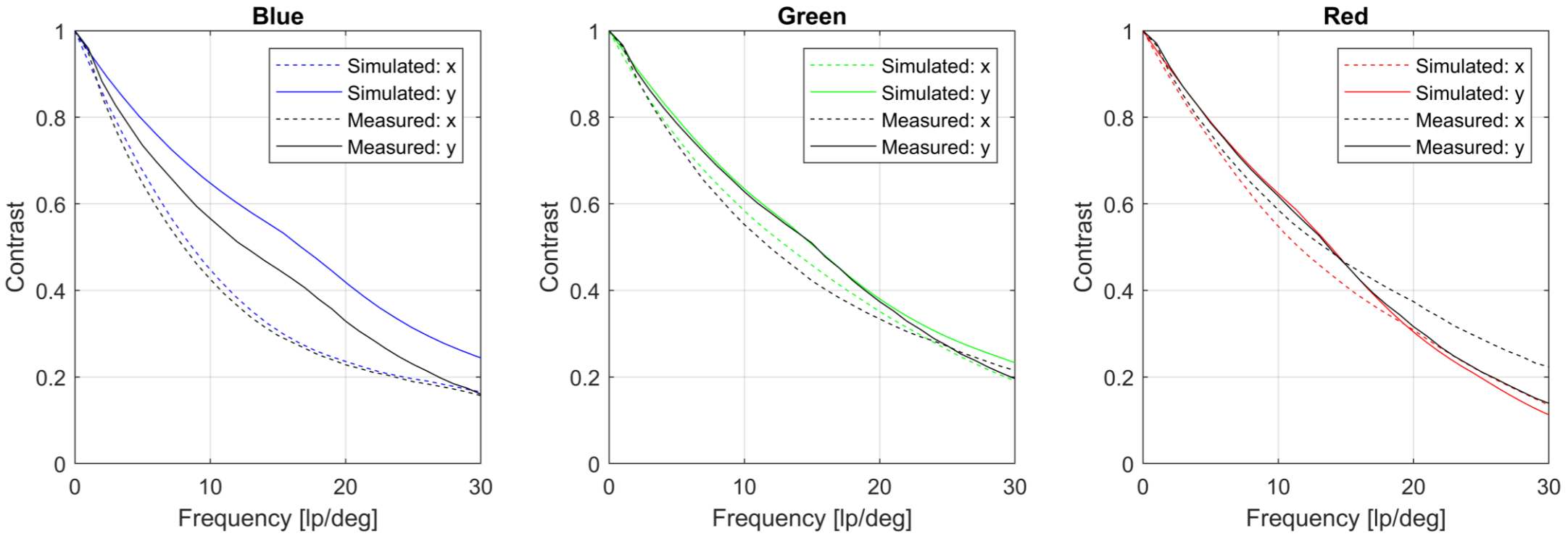
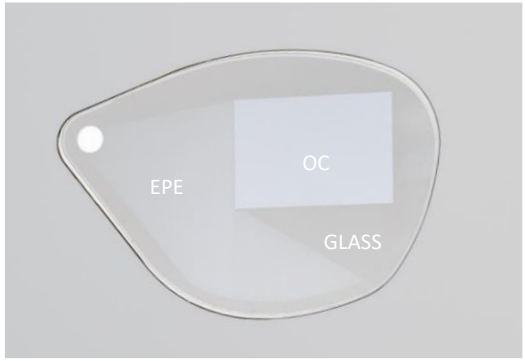


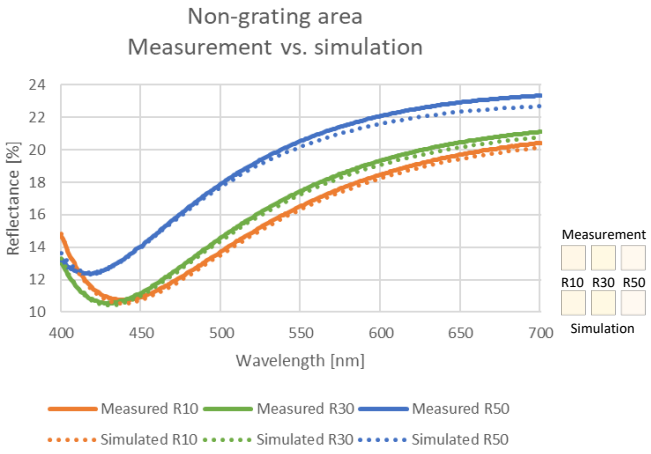
Photo credit www.edmundoptics.com

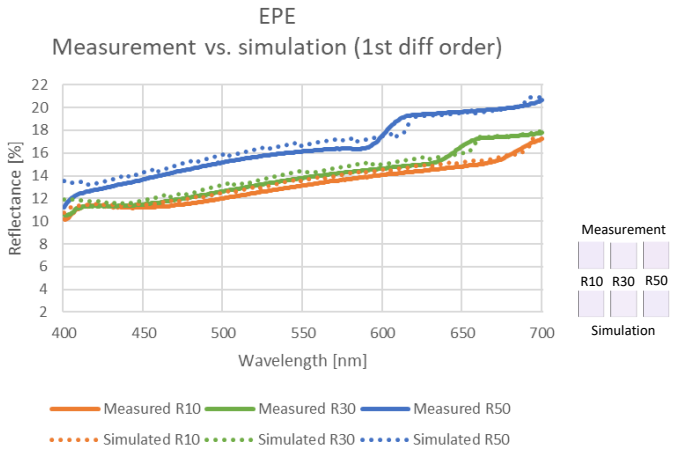
MTF Simulation vs. Measurement

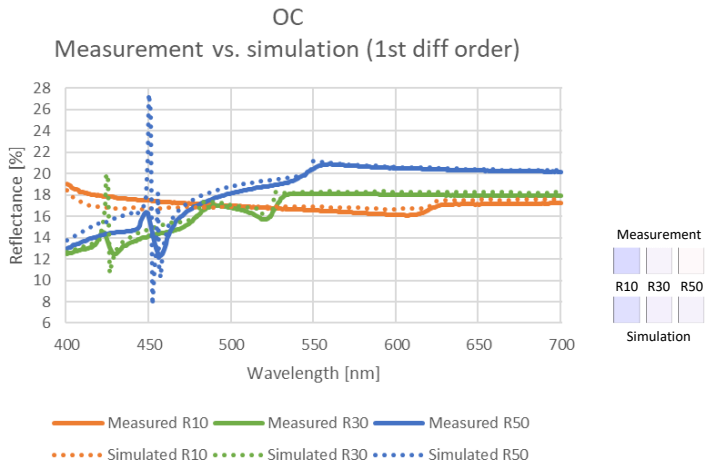


Visual appearance









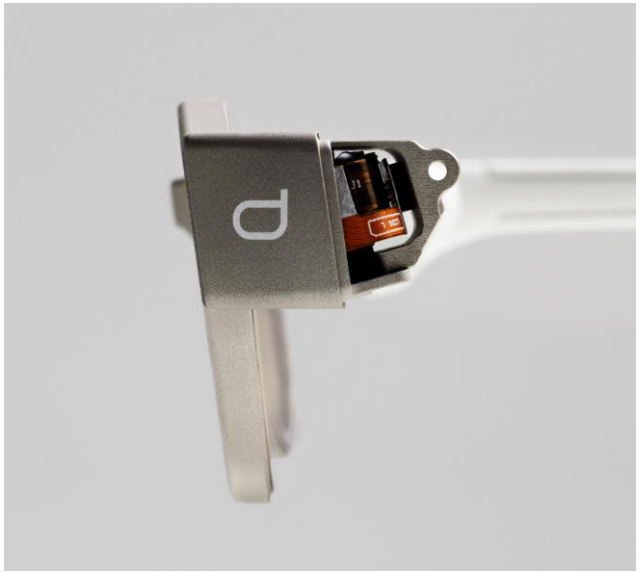
Interface

Mechanical design

Angles
Clearing distance

Waveguide combiner in-coupler

In-coupler grating design
In-coupler diameter



Light engine

Beam characteristics
Luminous spectrum

From design to delivery

DESIGN FOR MANUFACTURING

VERIFICATION AND VALIDATION

MASS MANUFACTURING

METROLOGY AND QUALITY

SUPPLY CHAIN MANAGEMENT

Dispelix in-house design tool

Powerful software toolset to explore new waveguide and grating concepts

Simulates nano-scale diffractive gratings and waveguides with macro-scale dimensions

Fast and efficient in solving complex multi-objective problems

Embedded tolerancing for manufacturing

Correlation between simulated and measured values excellent