



phaseform

Seeing Beyond Limits: Phaseform's DPP and the Evolution of Adaptive Optics in Ophthalmology

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CTO & Co-founder
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3 June 2024, 15:00 - 17:00 CEST

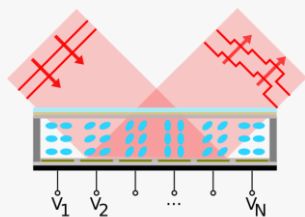
EPIC Online Technology Meeting on
Photonics for Vision and Eye Research



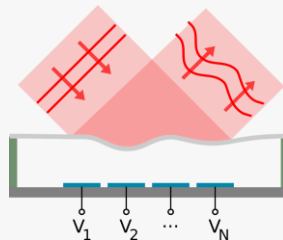
Deformable Phase Plate constitutes a New class of optical devices



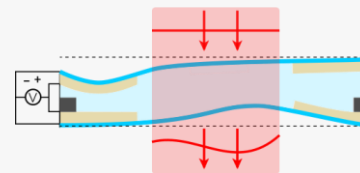
Liquid Crystal
Spatial Light Modulators



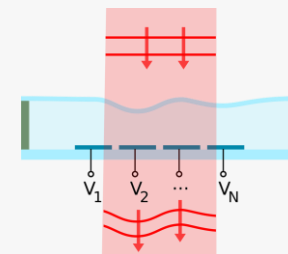
Deformable
Mirrors



Tunable &
Adaptive Lenses



Deformable Phase Plate



phaseform

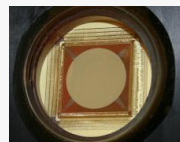


DELTA 7



HOLOEYE

GAEA-2

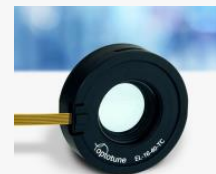


ALPAO

imagine² optic

BOSTON
MICROMACHINES
CORPORATION
SHAPING LIGHT

KiloDM



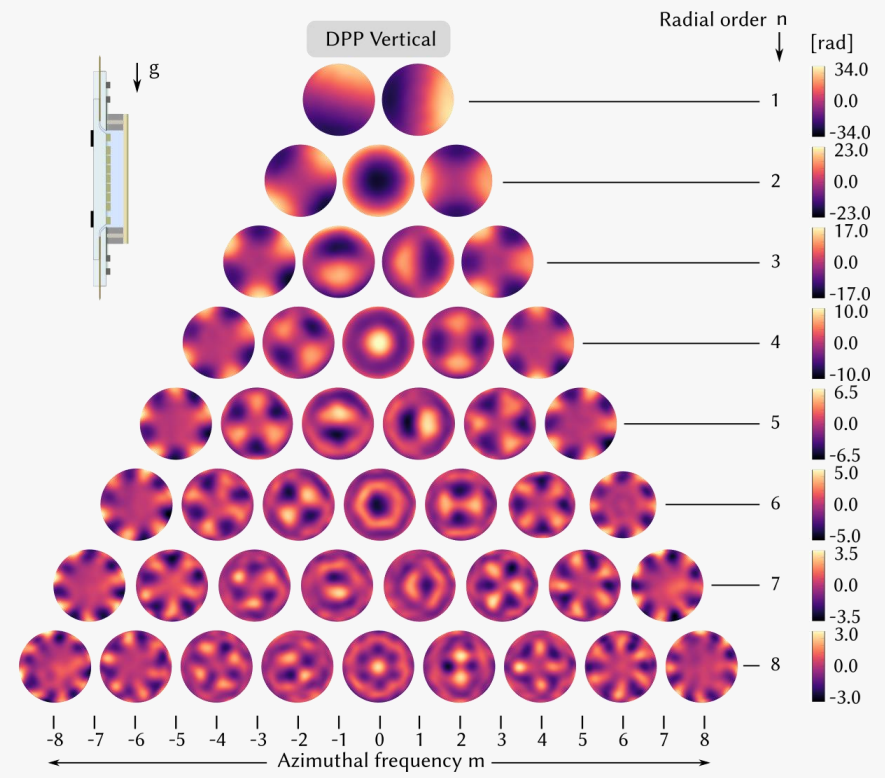
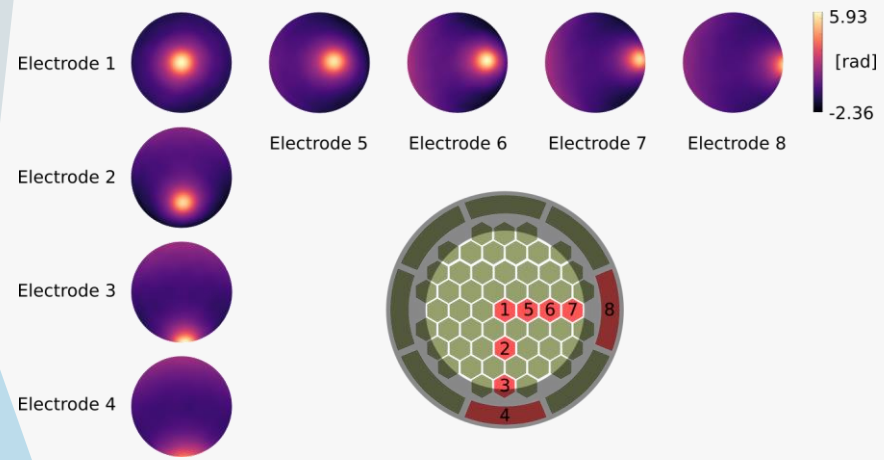
CORNING
Varioptic[®] Lenses

optotune

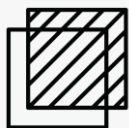
EL-16-40-TC

DYNAMIC
OPTICS

Zernike Mode Replication



Phaseform's Patented: Deformable Phase Plate (DPP)



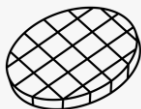
Transmissive;
Polarization & diffraction-free, Stackable



Ultra-thin and
continuous-surface

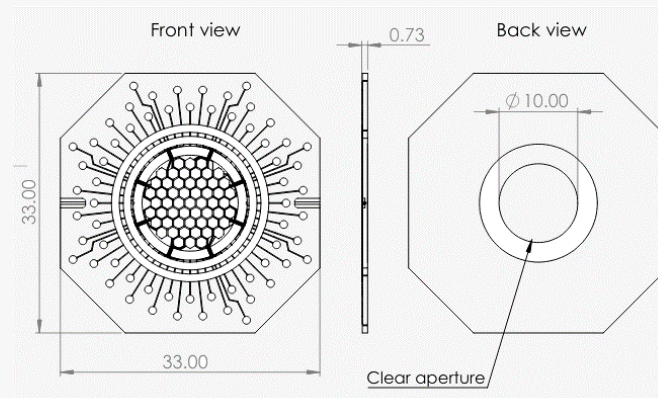
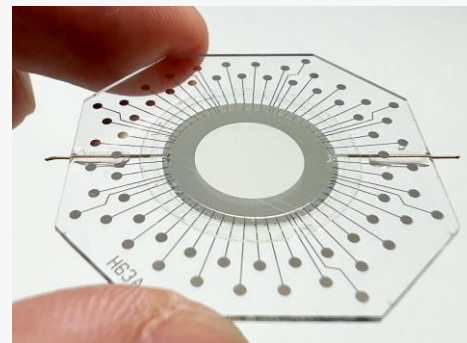


Easy integration & retrofits



Scalable; Wafer-level manufacturing

Technology



DELTA 7 Refractive Wavefront Modulator

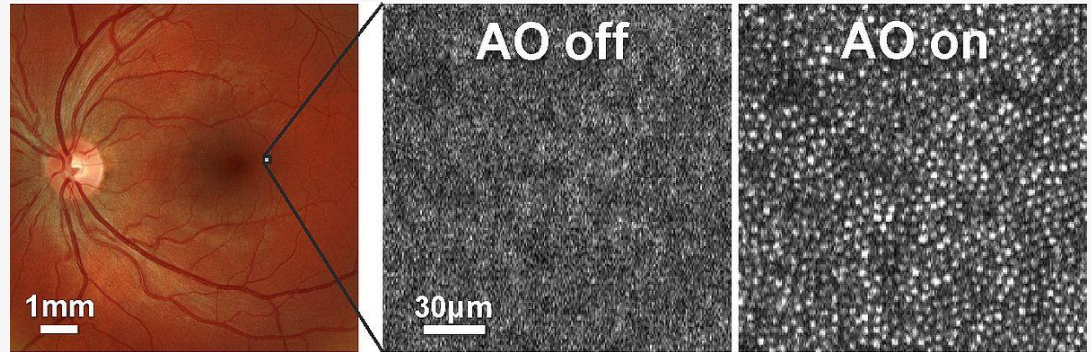
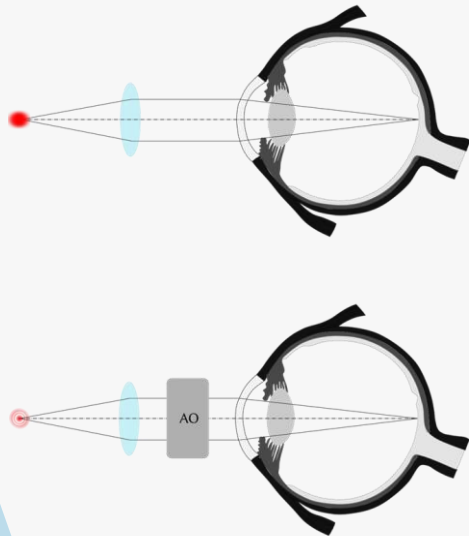


Number of actuators	63
Maximum Peak to Valley	> 8 μm OPD
Response time	< 55 ms
Optical transmission	400 nm - 2200 nm (no AR coating): 80% at $\lambda=800$ nm
Hysteresis	< 1 %
Linearity	> 92 %
Laser Induced Damage Threshold	10 W/cm ² for 10 sec @ 1070 nm CW
Optical aperture	10 mm \varnothing
Thickness in optical path	0.87 mm
Mounting	30 mm cage system, SM1 tubing
Highest order of correction	7th radial order Zernike

Adaptive Optics for Ophthalmology



Enabling cellular resolution retinal imaging



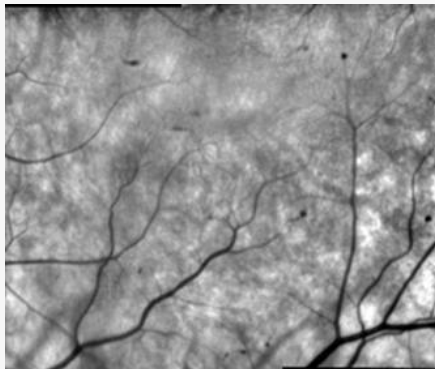
Courtesy of **Wolf Harming**
Department of Ophthalmology, University of Bonn

Adaptive optics enables Early detection of blinding eye diseases



Adaptive Optics-enabled retinal imaging

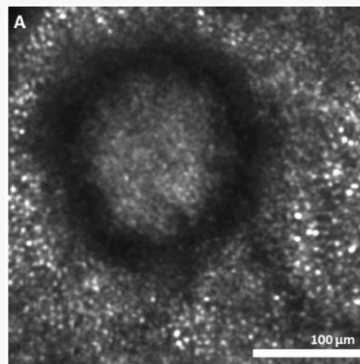
Diabetic Retinopathy subject



AO retinal camera shows microaneurysms making early intervention possible.
Source: Profundus



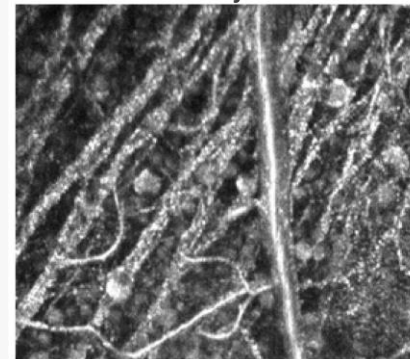
AMD subject



Cone mosaic surrounding a subretinal drusenoid deposit in a 73-year-old male with non-neovascular AMD. Source: Y. Zhang, et al. (2014)



Glaucoma subject



Glaucomatous retinal ganglion cells visible through AO-OCT. Note lower cell density and enlargement. Source: Liu, Zhuolin, et al. (2021)

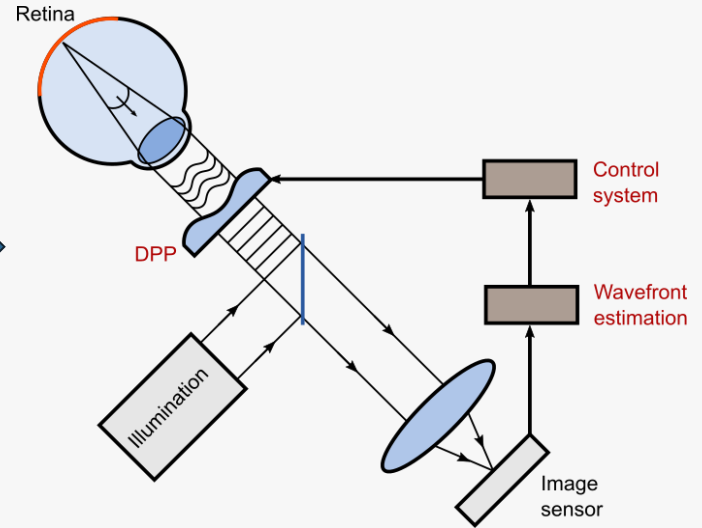
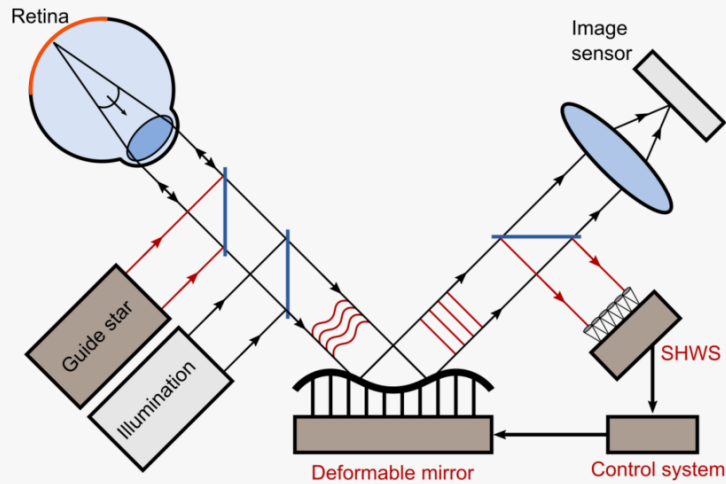
EARLY GLAUCOMA



EXTREME GLAUCOMA



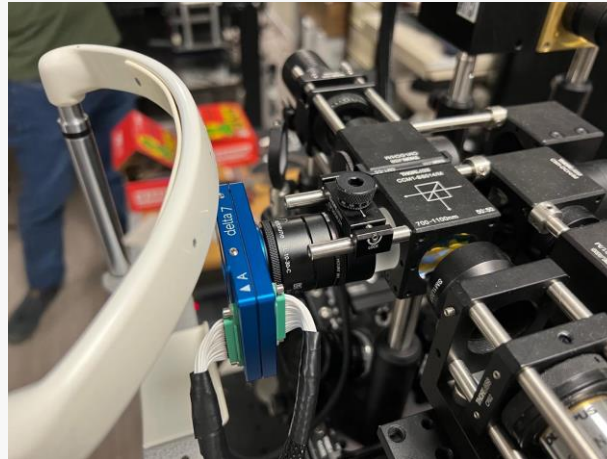
Refractive Adaptive Optics



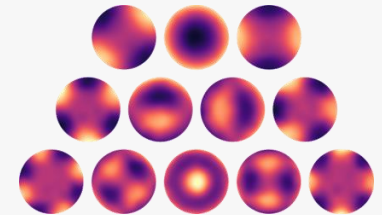
DPP for Ophthalmoscopy



- Plug-and-play AO experiment with existing full-field OCT-based ophthalmoscope



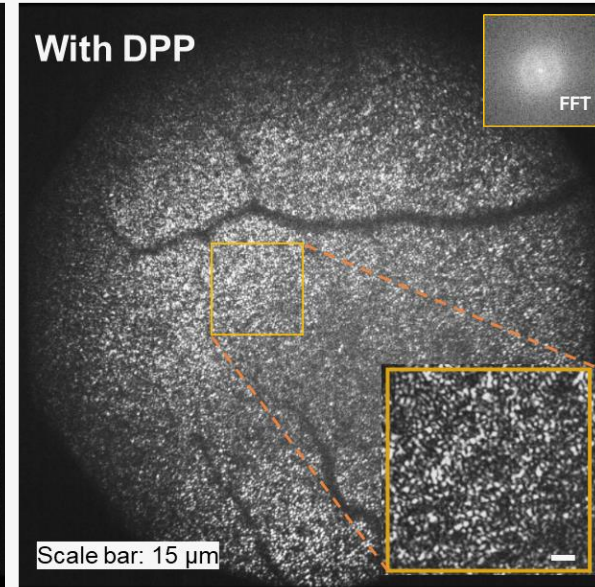
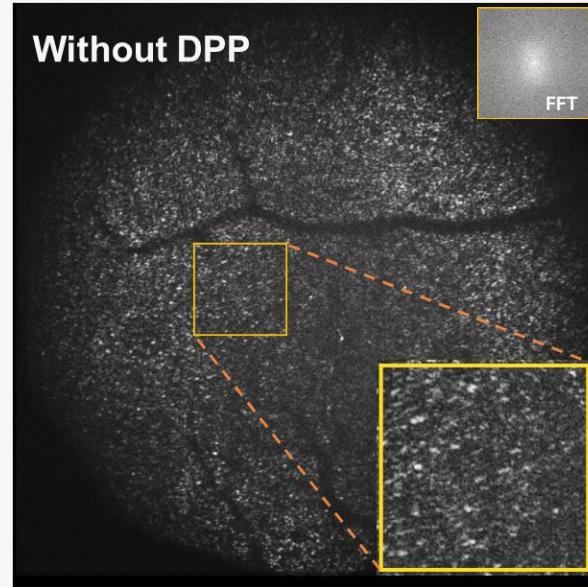
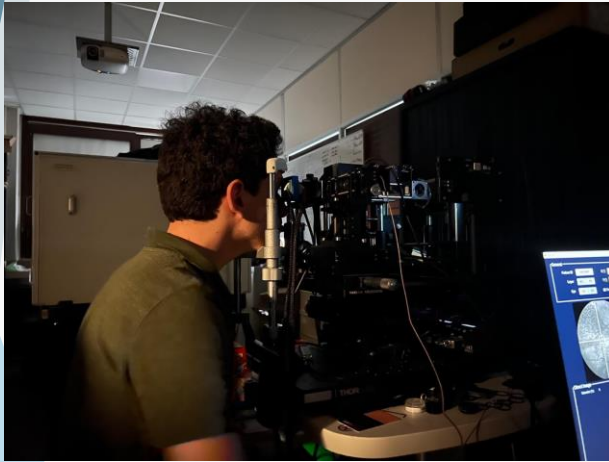
Aberration modes considered for wavefront sensorless correction



DPP for Ophthalmoscopy



- Plug-and-play AO experiment with existing full-field OCT-based ophthalmoscope

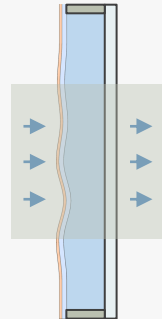
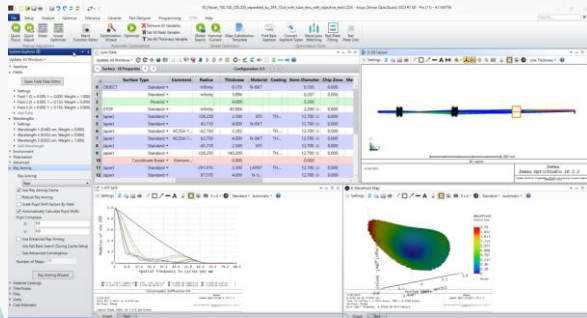


- **Wavefront sensorless measurement** and **active compensation** of system and sample induced optical aberrations by DPP

DPP Zemax Model



- In the form of a dynamic-link library (DLL) that may be imported into the Zemax OpticStudio lens editor environment
 - Based on the empirically measured characteristics and responses of a real DPP
 - Incorporates performance boundary conditions of DPP
 - Beam diameter range between 6.0 mm to 10 mm
 - Choice of optimization in Zernike (up to 36 modes) or Voltage space (63 electrodes)
 - Calculates the corresponding optimized voltage values which may be applied in-situ



Visit www.phaseform.com to download and test the DPP's Zemax model for free



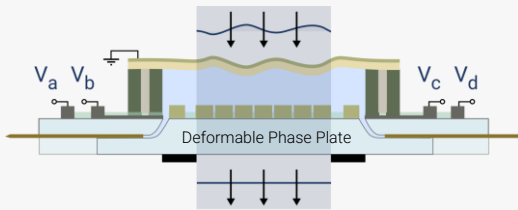
Concluding Remarks

Online & social media:

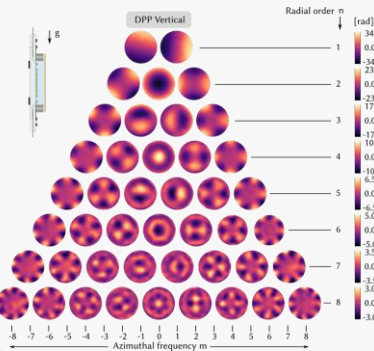
Email: pr@phaseform.com
 Web: www.phaseform.com
 LinkedIn: [linkedin.com/company/phaseform](https://www.linkedin.com/company/phaseform)
 Twitter: [@phaseformgmbh](https://twitter.com/phaseformgmbh)



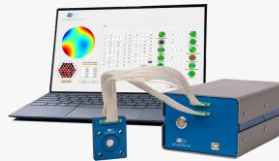
A deformable mirror, but **transparent**



Replicates complex Zernike modes



Enabling novel, more compact and performant **optical systems** & solutions

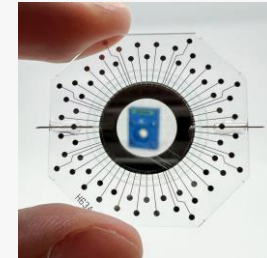


Phaseform Delta 7
DPP-based development kit

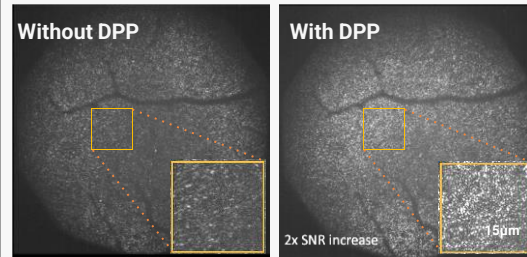
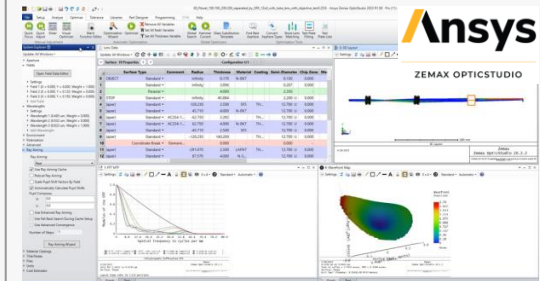


FF-OCT retrofitted with
Phaseform Delta 7

Digital model of DPP representing its **empirical** properties



→ insert into OptiStudio just as you would insert a lens DLL



Institut Langevin ONDES ET IMAGES Courtesy of Dr. Kate Grieve & Dr. Pedro Mecé at Institut Langevin in Paris