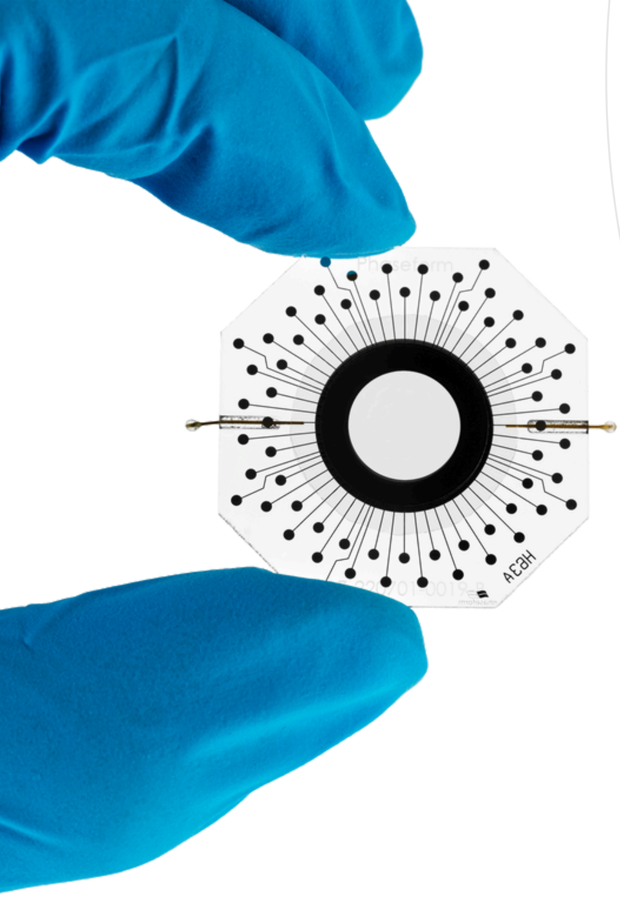

PHI PROTO

The Ultimate *Plug-and-Play*
Adaptive Optics Platform for Microscopy

Next-generation aberration correction &
fast remote focusing, all in one compact unit

WHAT IS IT?

Phi Proto is Phaseform's prototype of **Phi**, a camera port attachment that seamlessly brings adaptive optics (AO) to microscopes. It features a transmissive wavefront modulator (our proprietary **Deformable Phase Plate** or DPP) located at the microscope's pupil plane for precise aberration correction, plus an integrated tunable lens for ultra-fast remote focusing.

KEY FEATURES

- **Plug-and-Play**: Attaches to any standard C-mount camera port - connect power and USB, and you're good to go!
- **Modular**: Easily insert or remove the DPP to switch between standard imaging and adaptive optics.
- **Software Integration**: Compatible with µManager, ScanImage, and upcoming plugins for popular microscope software. Python SDK is available for custom workflows.
- **Future-Proof**: Works with current & upcoming DPPs. Just swap in the DPP that suits your application.

Adaptive Optics for Deeper, Clearer Imaging

- Correct up to the 7th radial order of Zernike modes
- Sensorless AO approach with user-friendly image-based aberration measurement.
- Automatically optimize image quality for thick, scattering tissue samples.

Motionless 3D Focusing

- Integrated Tunable Lens at the conjugate pupil plane with up to 15 diopters focusing range.
- Sub-3 ms response time for fast, z-stack imaging.
- Perform rapid 3D volumetric imaging by refocusing the object plane without physically moving the objective or stage.

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SPECIFICATIONS

Compatibility

Microscope	Mounts onto any standard C-mount port. Chain multiple C-mount devices: confocal & spinning-disk modules, etc.
Objective lens ($D\_pupil \simeq 2 \times f\_obj \times NA = 2 \times (f\_tube / Mag) \times NA$)	Covering objective lenses with various pupil diameters ranging from 5 mm to 20 mm. 5 - 11 mm (available now) 11 - 20 mm (available Q4 2025)
Software	µManager, ScanImage, Python SDK (for more get in touch)

Adaptive Optics

Maximum peak-to-valley of the corrected wavefronts	> 10 µm
Maximum spatial frequency of the correction	7th radial order of Zernike modes
Response time	<55 ms

Remote focusing

Tuning range	up to 15 dpt
Tuning precision ($\Delta z\_object \simeq \Delta diop \times f\_obj^2 = \Delta diop \times (f\_tube / Mag)^2$)	0.001 dpt
Response time	3 ms

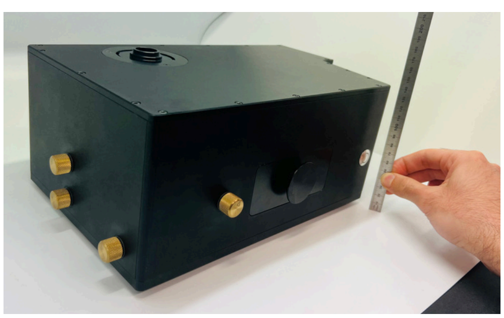
Wavefront Sensing Addon (H1'26)

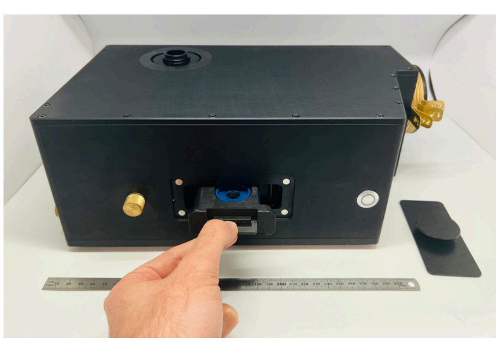
Optional module to connect a wavefront sensor. Compatible to all customary wavefront sensors

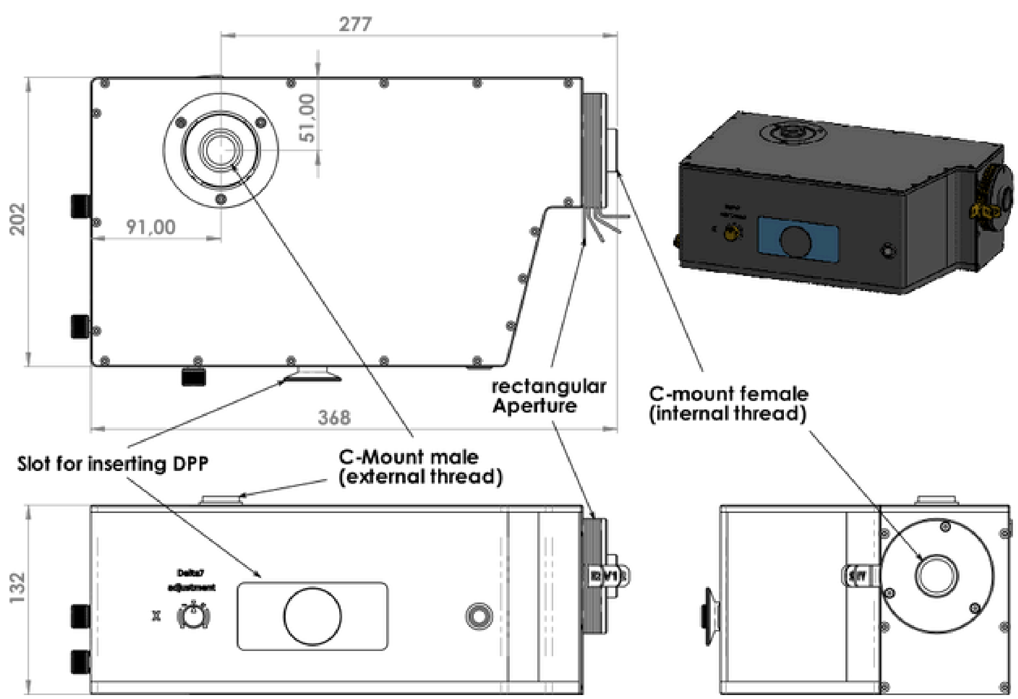
General

Optical transmission - AO & Remote focusing mode	> 62% avg (450 nm - 1050 nm)
Optical transmission - bypass mode	> 90% avg (450 nm - 1050 nm)
Power/Connectivity	12V wall power, USB to PC
Weight	8.3 kg

PHOTOS







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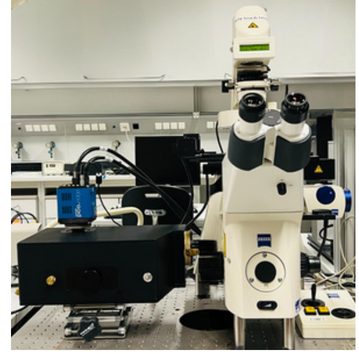
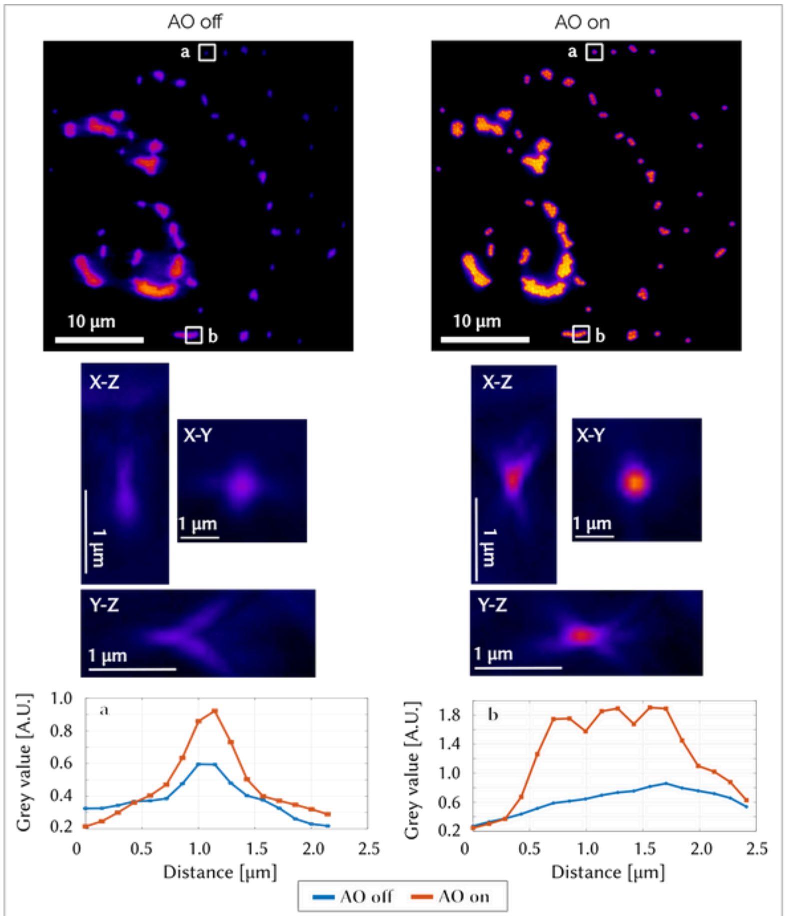
PROTO RESULTS

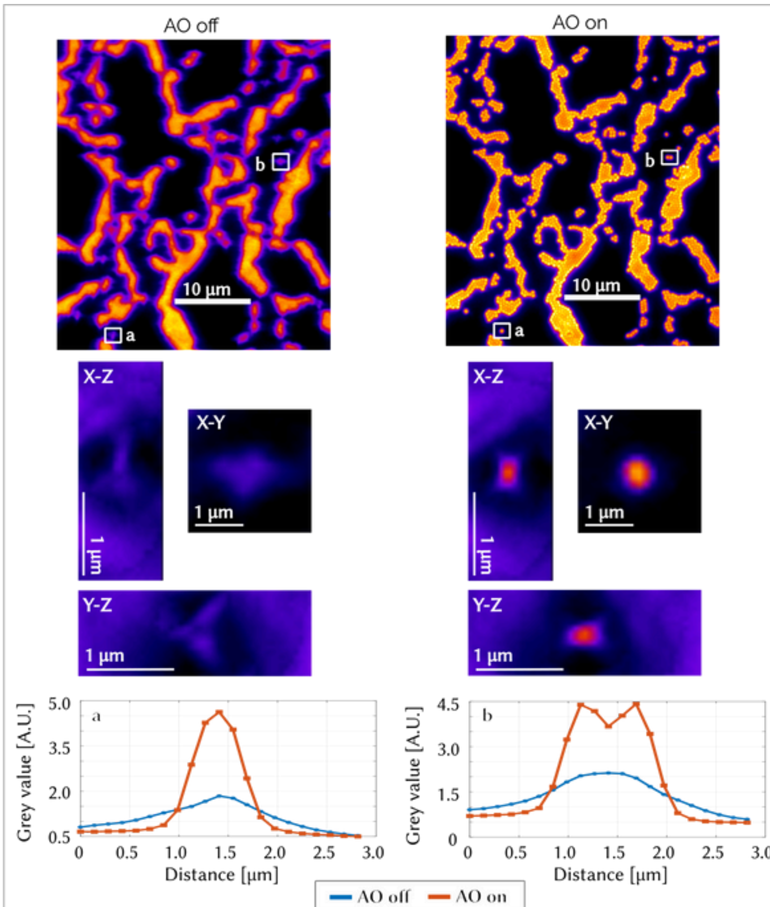
Tested on a Zeiss Axiovert 200M, Camera: sCMOS, PCO.edge 4.2LT

Microscope kindly provided by Life Imaging Center (LIC) Freiburg (Dr. Roland Nitschke)

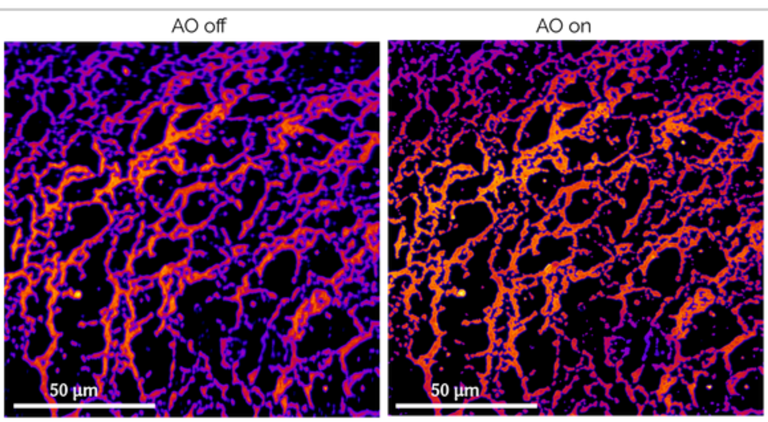




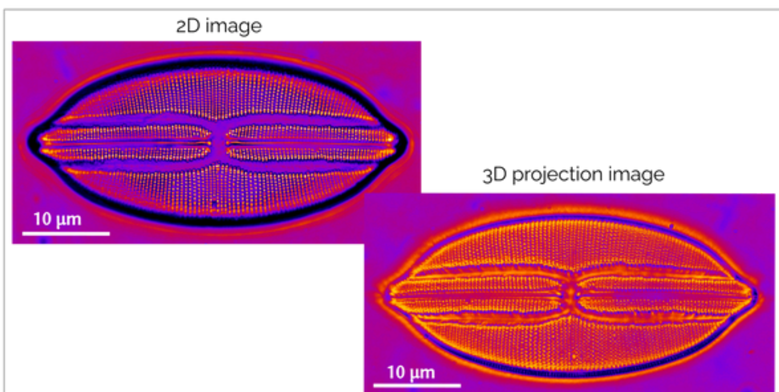
Fluoresbrite® YG Microspheres (0.50 µm) imaged with a Zeiss 40x/1.3 NA oil objective using mismatched immersion (n = 1.566 instead of n = 1.518). Left: Without AO. Right: With AO correcting spherical aberration and other modes up to 4th-order Zernike. A z-stack made of 51-layers is captured (170 nm steps via tunable lens). Top and cross-sectional views of a single bead shown.



Same beads and objective with correct immersion (n = 1.518). Poor sample mounting introduces strong astigmatism. Left: Without AO. Right: With AO correcting aberrations up to 4th-order Zernike (12 modes). Images are 51-layer z-stacks (170 nm steps). Top and cross-sectional views of a single bead shown.



Widefield image of Fluoresbrite® YG Microspheres (0.50 µm) using a Zeiss 40x/1.3 NA oil objective. Left: Without AO. Right: With AO correction via a DPP placed precisely at the objective's pupil plane using Phi Proto's embedded relay optics. This configuration enables uniform aberration correction across the entire field of view.



Navicula Lyra imaged with a Zeiss 100x/1.3 NA oil objective. Left: Single focal plane. Right: 3D projection from a 241-layer z-stack captured using Phi Proto's integrated tunable lens, placed at the objective's conjugate pupil plane. The stack is stepped in 0.005 diopter increments, corresponding to ~14 nm axial steps in object space, spanning a total depth of ~3.4 µm.

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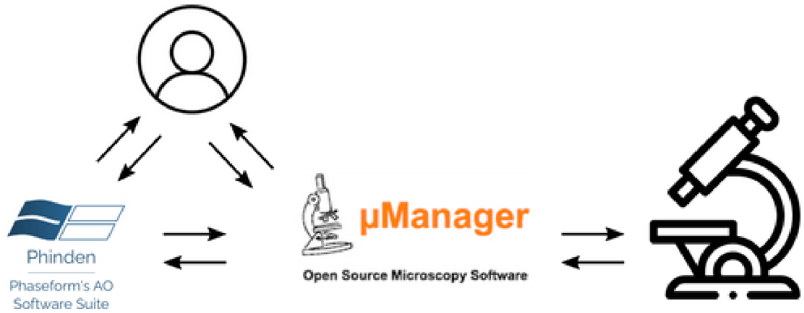
SOFTWARE

Phi Proto comes standard with **Phinden***, Phaseform's image-based AO software suite that drives the DPP, enabling automated measurement and correction of optical aberrations. It integrates seamlessly with existing microscope control software—including **µManager** and **ScanImage**—and maintains your current workflow by communicating directly with these platforms in the background. Users continue to operate their preferred control software as usual while Phinden handles the aberration measurement and DPP adjustments to optimize image quality in real-time.

- **No Workflow Disruption**: You keep using your microscope software; Phinden just talks to it for AO.
- **Future Expansion**: Interested in another software platform? Get in touch for details.

*The name *Phinden* combines "Phi" (the Greek letter often used to represent phase) with the German verb "finden" ("to find").



CO-DEVELOPED WITH AKRIMA GMBH

Phi Proto has been co-developed with akrima GmbH. To learn more about akrima imaging solutions and their offerings visit their website www.akrima.at

akrima

akrima GmbH
Rheinstraße 4
6971 Hard
Austria

INTERESTED?

We're selecting early adopters for hands-on experience with Phi Proto. Sign up to:

- Trial the latest adaptive optics solutions in your own lab.
- Receive direct line to our R&D team.
- Influence the final design and software features.

scan me

https://forms.gle/QbPQhj393BZSx71G8

DISCLAIMER

Phi prototype is not a commercial product but an early preview version. All specifications are preliminary and subject to change without notice.

CONTACT US

Phaseform GmbH
Georges-Köhler-Allee 302
79110 Freiburg i.B.
Germany

www.phaseform.com
info@phaseform.com
+49 761 216 0800 0

Phaseform **Delta 7**
Transmissive Wavefront Modulator

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