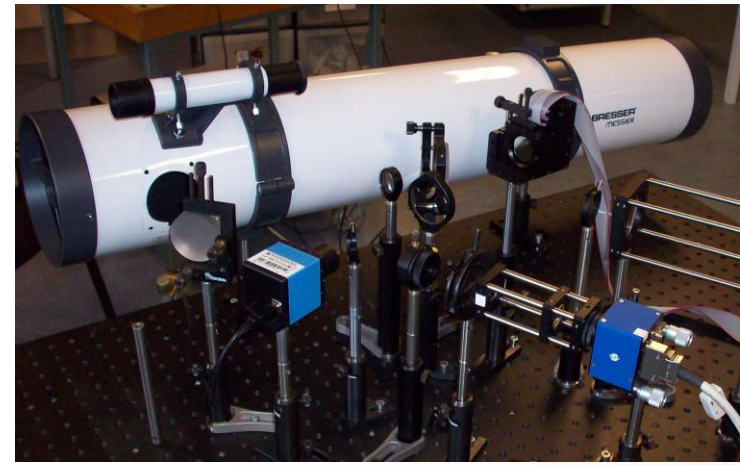
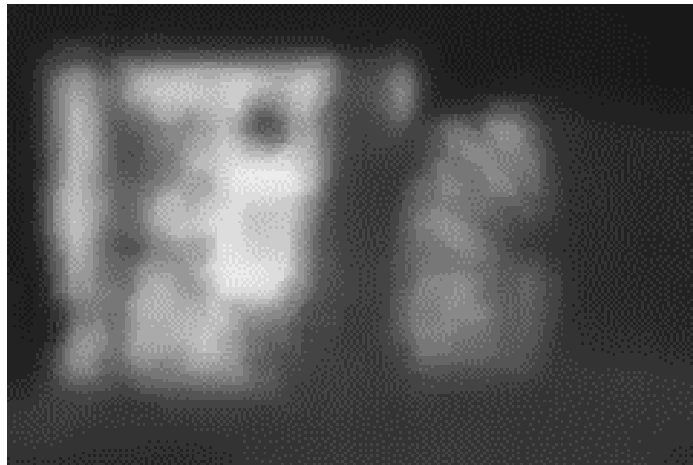


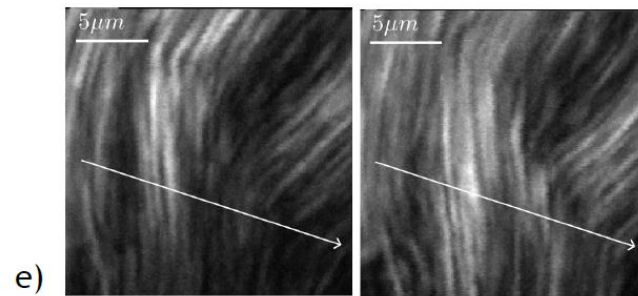
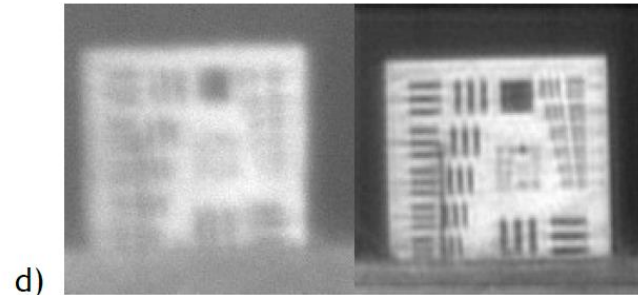
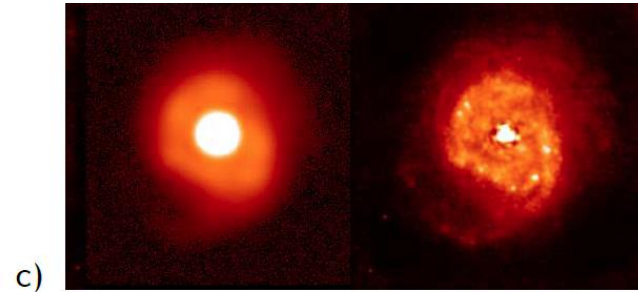
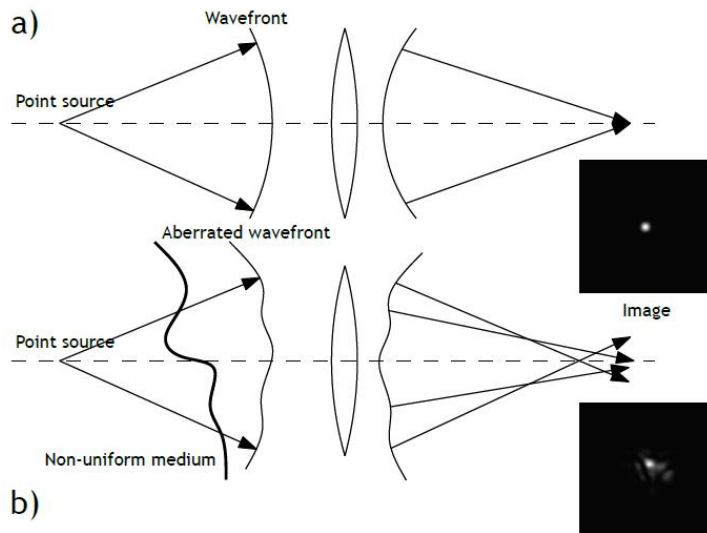
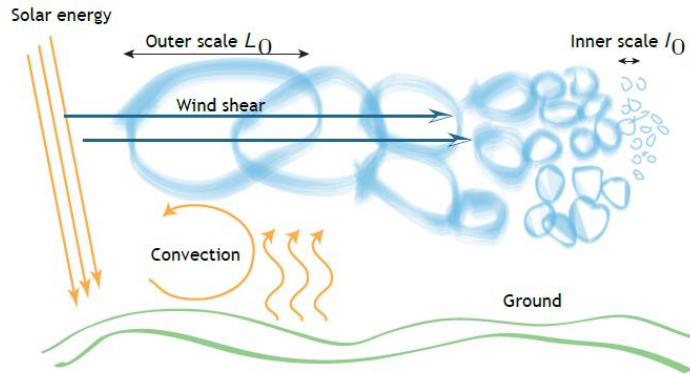
Oleg Soloviev
Flexible Optical BV
DCSC, TU Delft

MAGIC GLASSES

- development and production of low-cost Adaptive Optics (AO) systems
- Additional activity in the last years: *image enhancement with and without AO*

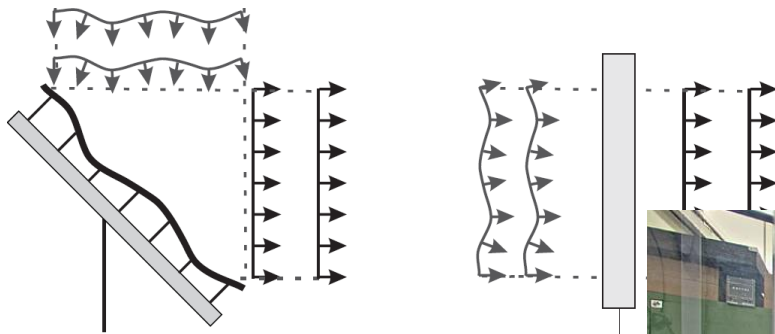


Adaptive Optics in a nutshell

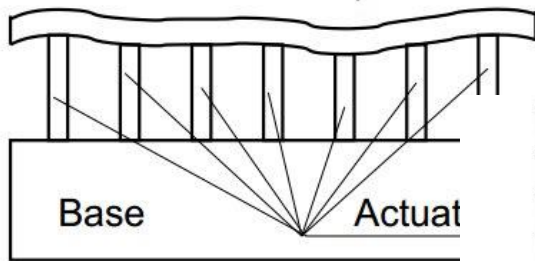


Adaptive Optics in a nutshell

Adaptive element to control the wavefront
 (Examples: OKO, ESO)

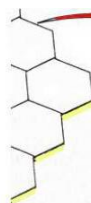


Flexible faceplate



Base

Actuat



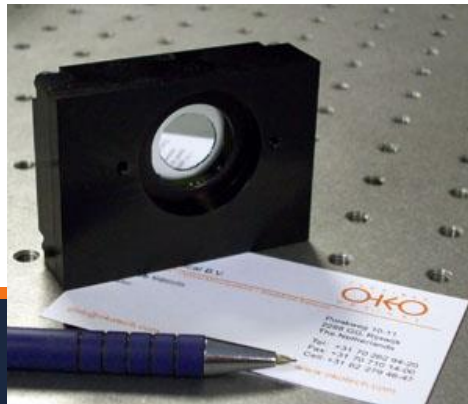
Actuator Deta

- (4) Shaft that connects to Whiffletree moves up or down in increments of 4 nanometers.
- (3) Hydraulic bellows reduces travel by 1/24.
- (2) Nut on rails moves up or down as the screw turns.
- (1) Computer-driven servo motor turns a screw as often as twice per second. Screw's pitch is one thread per millimeter.

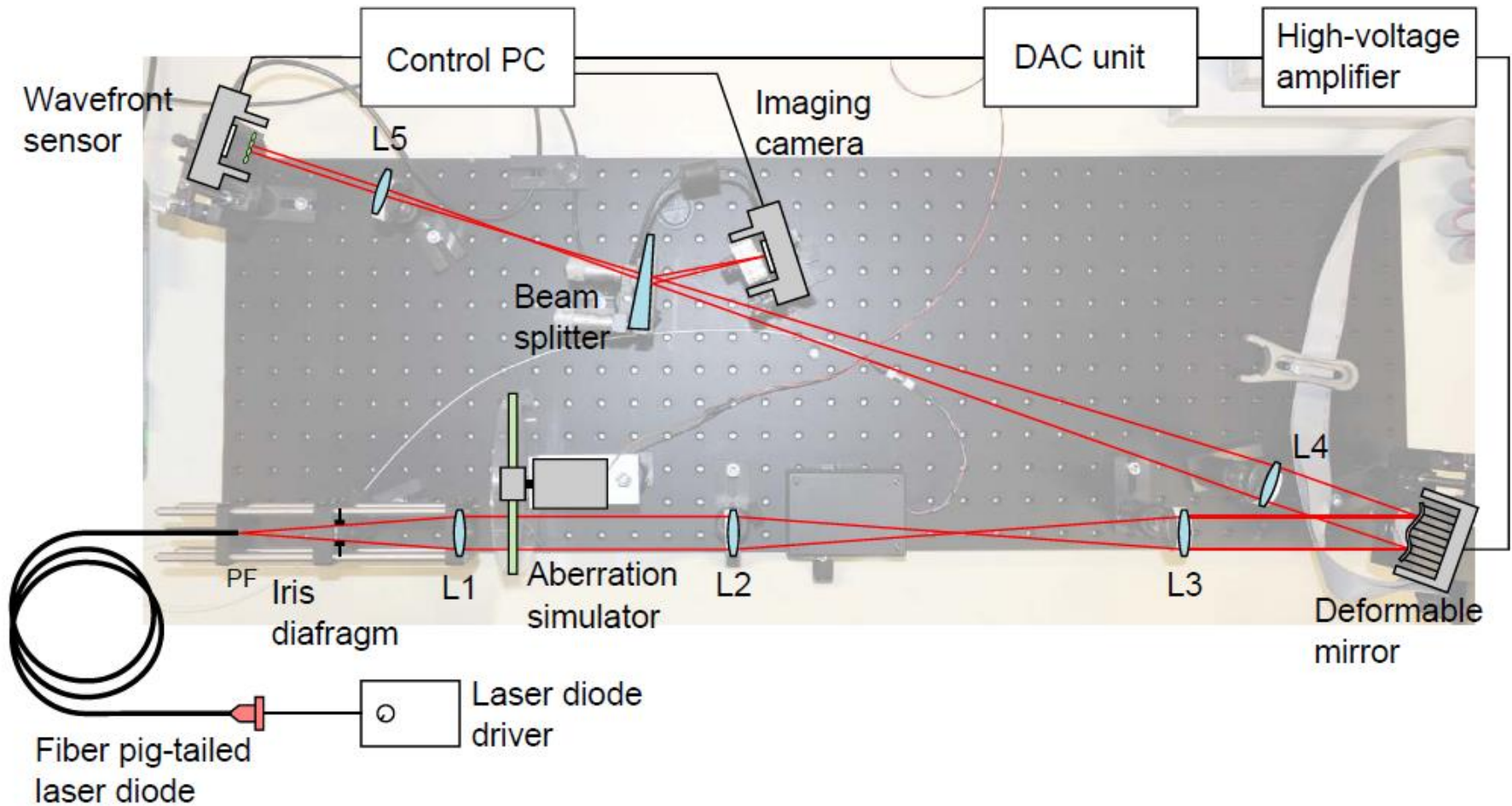


Actuators can be disconnected from the Whiffletrees for mirror segment removal. The Flex Disks and Whiffletrees are represented on your model by black printed detail on back side of the Primary Mirror segments. The Actuators are represented by 108 tiny vertical members on the Mirror Cell Upper part.

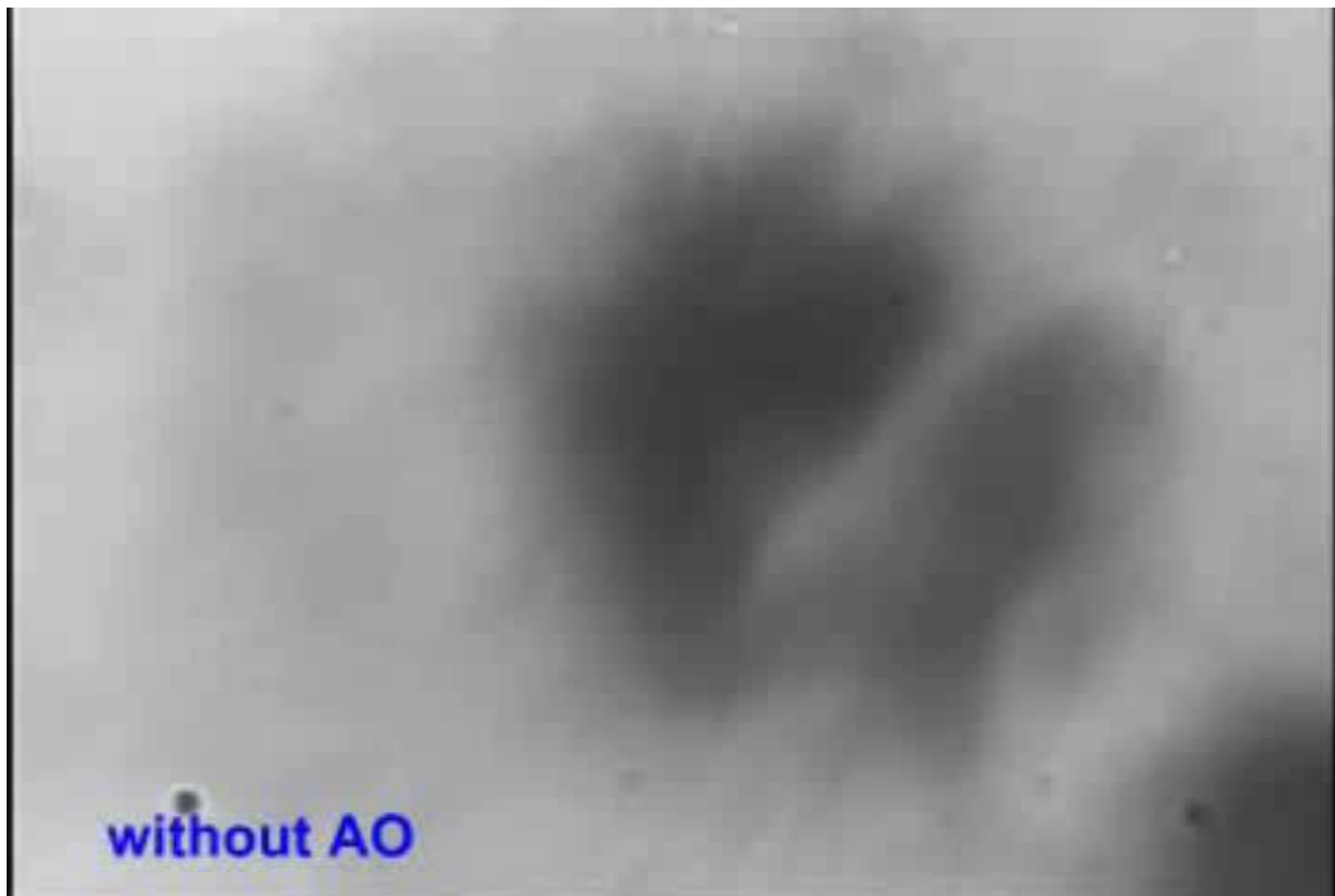
Encoder measures screw's angular position as input to computer. Each turn consists of 10,000 measured steps.



Adaptive Optics in a nutshell



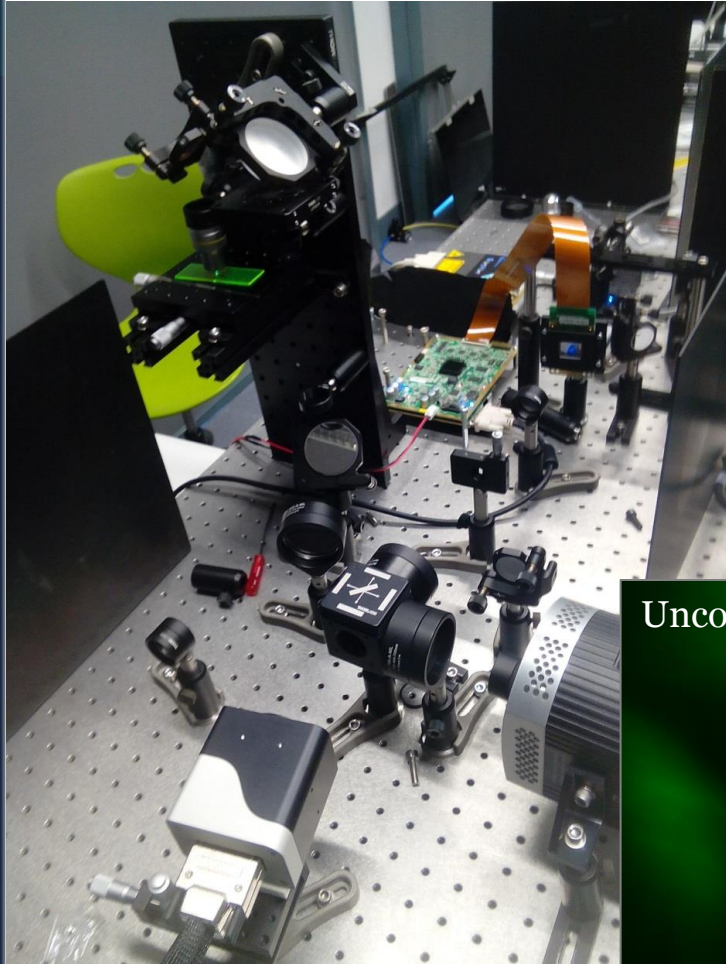
Adaptive Optics in a nutshell



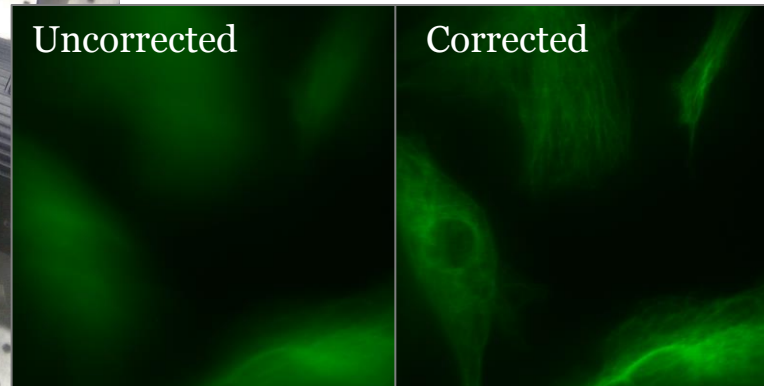
AO by SME on example of OKO

- Mission: affordable AO for *everyone* (price drop 2 orders of magnitude)



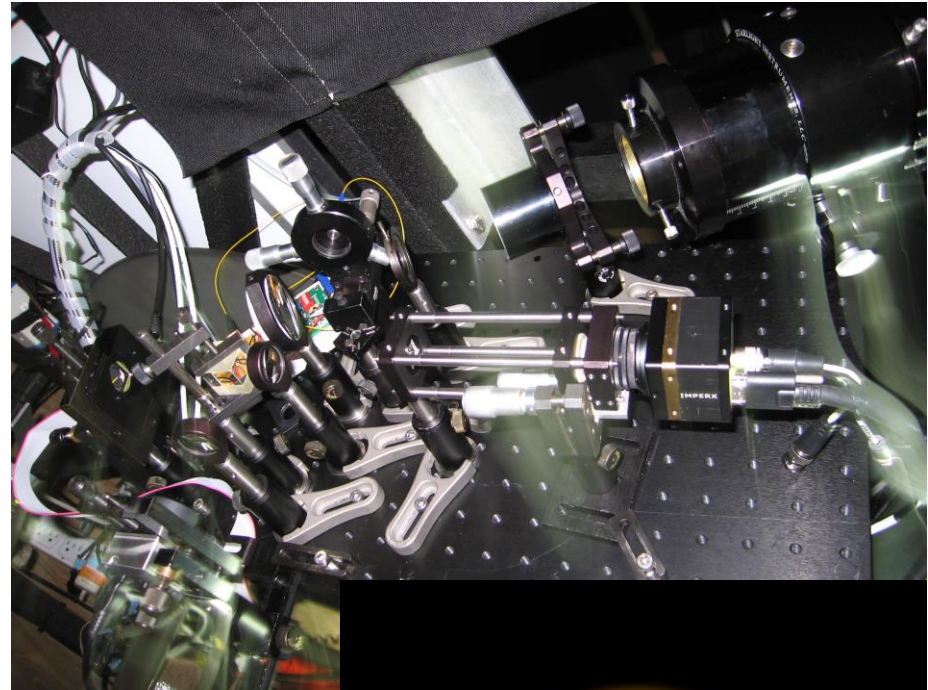


- Typical “University user”:
- ✓ AO is a tool
- ✓ DM/AO lenses/SLM from almost all manufacturers
- ✓ Interest is in microscopy (anisoplanatic AO)
- ✓ Explores also undocumented way of use
- ✓ Excellent results with any hardware but not user-friendly setups

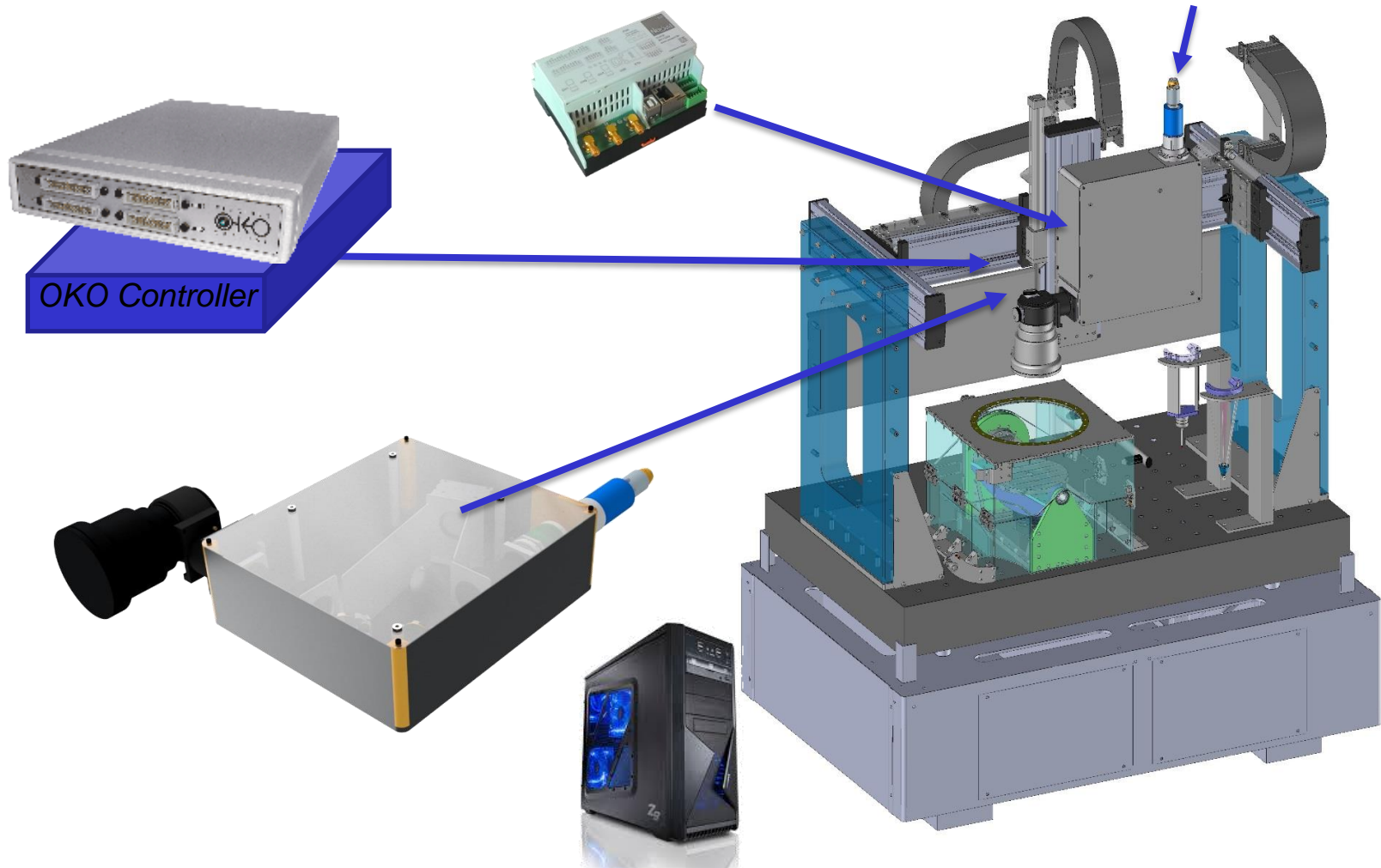


□ Amateur astronomer:

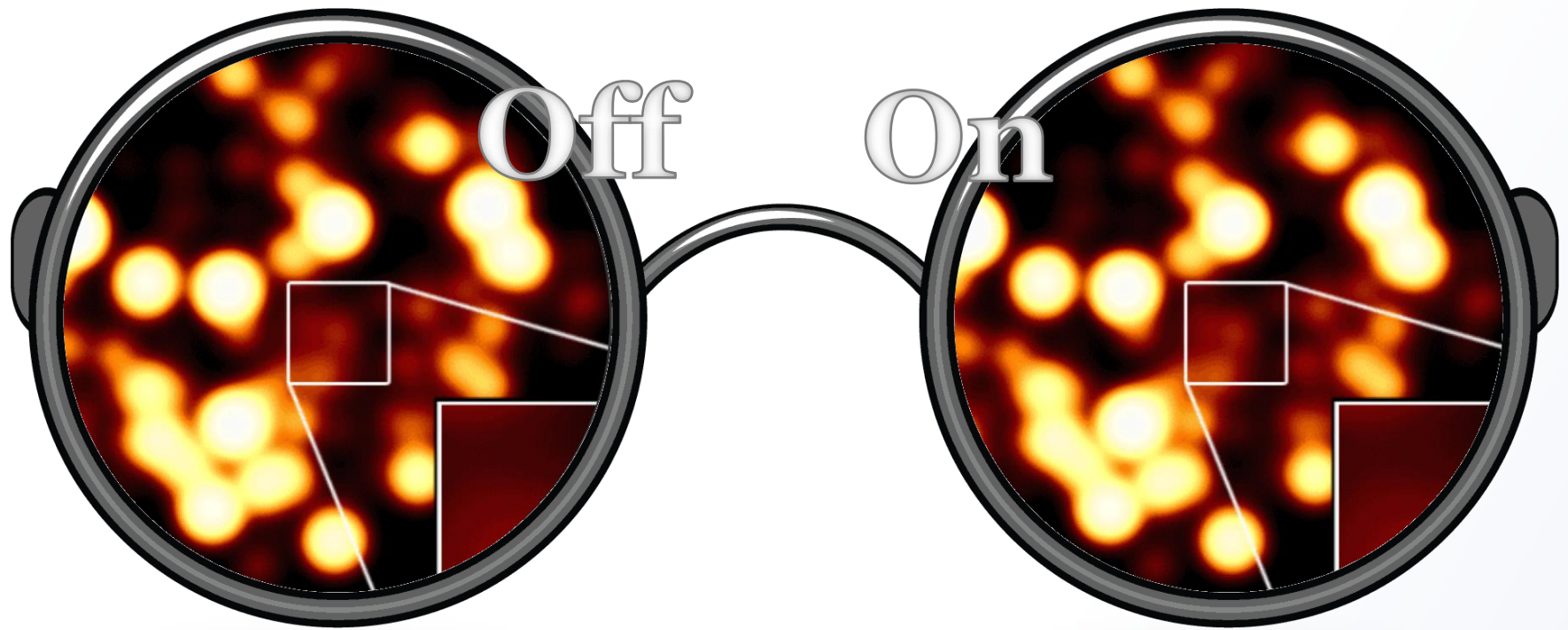
- ✓ AO is a toy
- ✓ Out of the box (basic) functionality
- ✓ Loves to play and fine tune (mostly through GUI)
- ✓ Unlimited time budget
- ✓ Limited money budget -> as multifunctional as possible
- ✓ Limited knowledge (often)



AO by customer (industry)



Dream device: Magic glasses

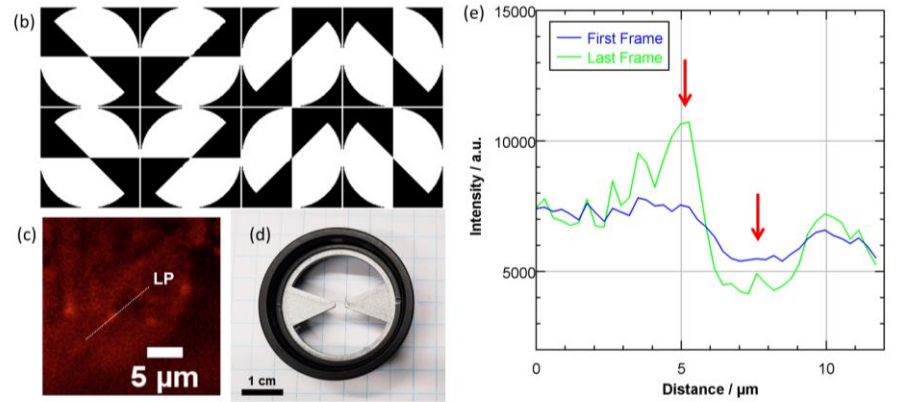
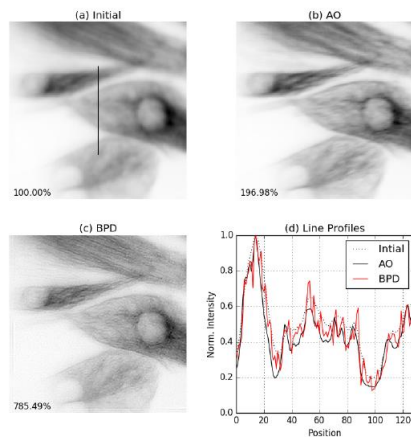


- ✓ Universal
- ✓ One button
- ✓ Self adjusting

- ✓ Self aligning
- ✓ Wide angle
- ✓ Anisoplanatic

First steps in this direction

- Restore object form several blurred images
- Introduce (random) aberration with AO instead of correction



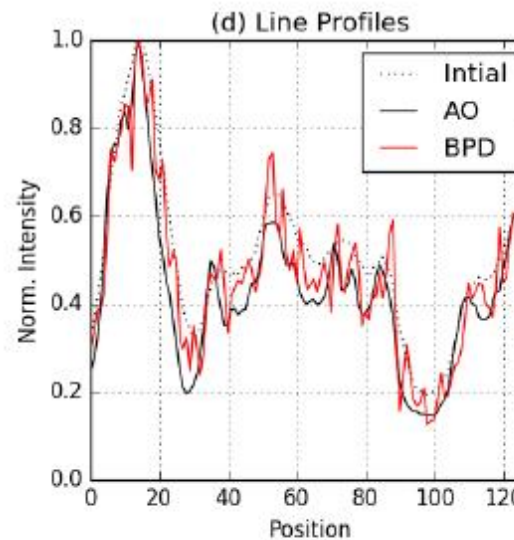
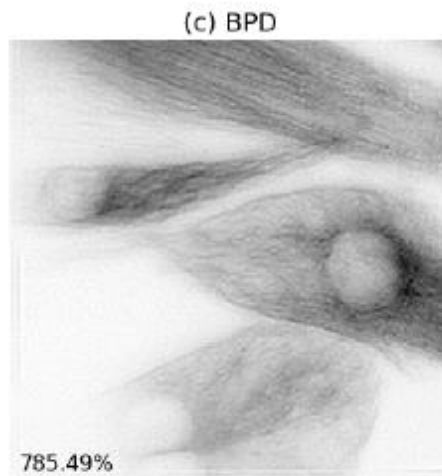
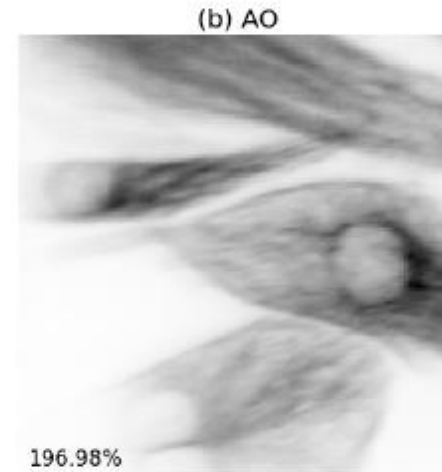
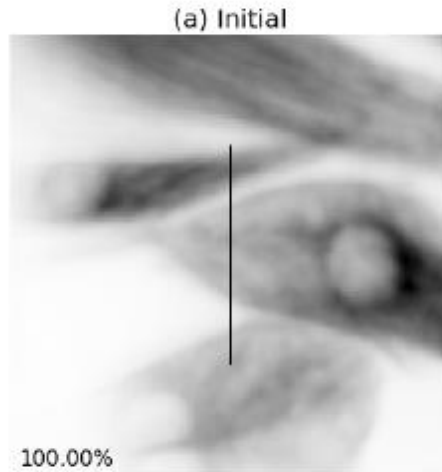
DCSC

Wilding, Soloviev, et al (2017). Blind multi-frame deconvolution by tangential iterative projections (TIP). Optics Express, 25(26), 32305. <http://doi.org/10.1364/OE.25.032305>

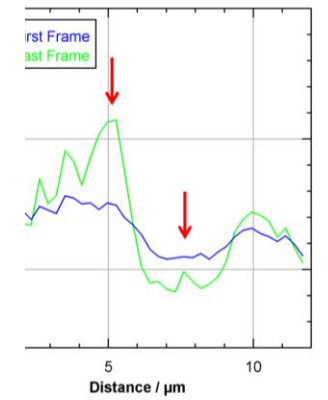
Wilding, Pozzi et al Pupil mask diversity for image correction in microscopy (in preparation)

First steps in this direction

- Restor
- Introd
- correct



head of



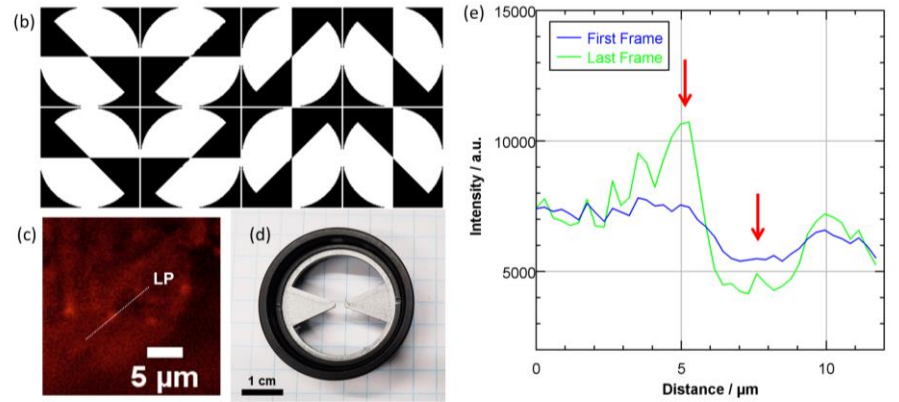
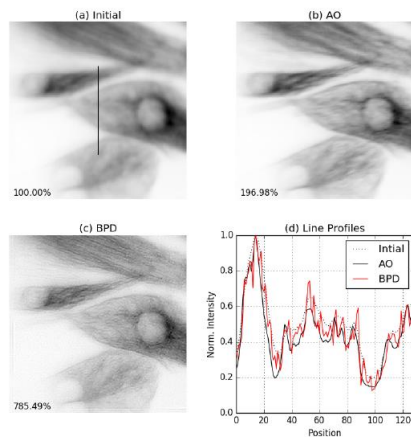
Wilding, Soloviev,
projections (TIP).
Wilding, Pozzi et



al iterative
:25.032305
(in preparation)

First steps in this direction

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- Introduce (random) aberration with AO instead of correction



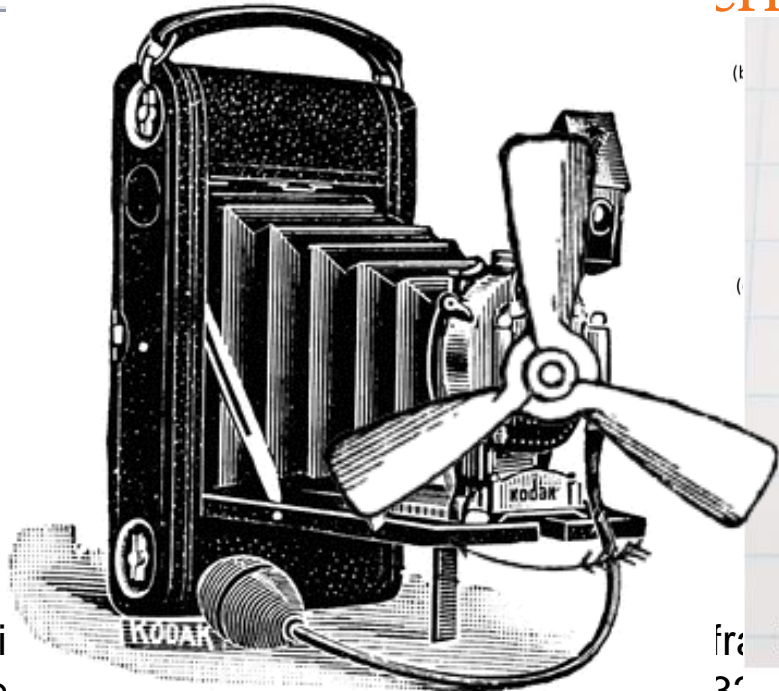
DCSC

Wilding, Soloviev, et al (2017). Blind multi-frame deconvolution by tangential iterative projections (TIP). Optics Express, 25(26), 32305. <http://doi.org/10.1364/OE.25.032305>

Wilding, Pozzi et al Pupil mask diversity for image correction in microscopy (in preparation)

First steps in this direction

- Restore object form several blurred images
- Introduce (random) aberration with AO instead of



Wildi

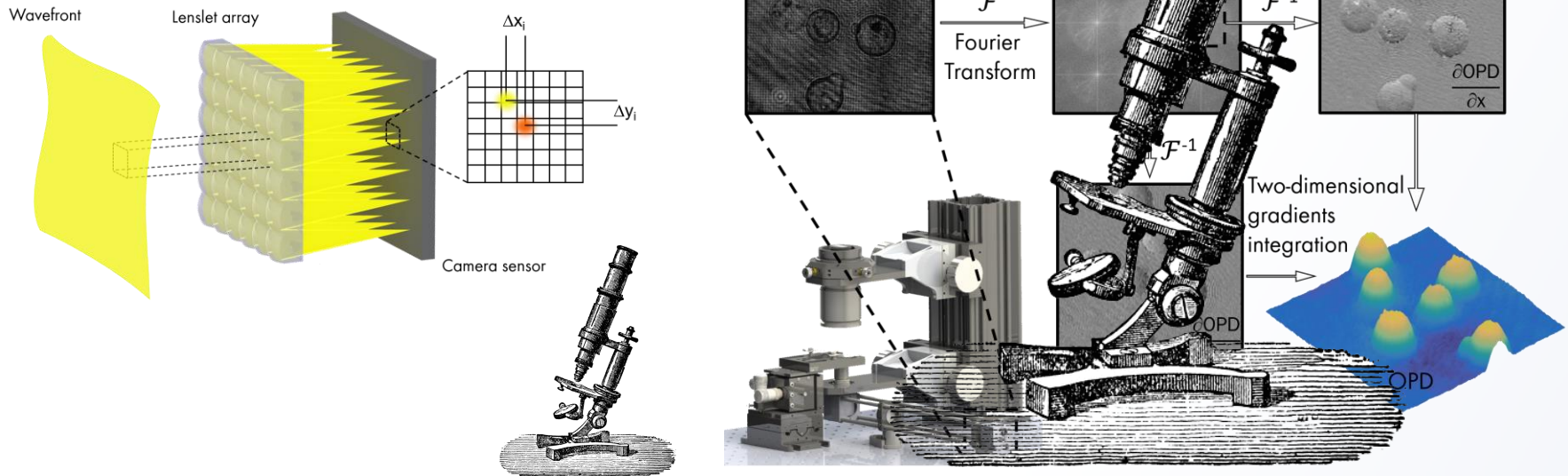
projections (111). Optics Express, 20(20), 32000. <http://dx.doi.org/10.1364/OE.20.032005>

Wilding, Pozzi et al Pupil mask diversity for image correction in microscopy (in preparation)



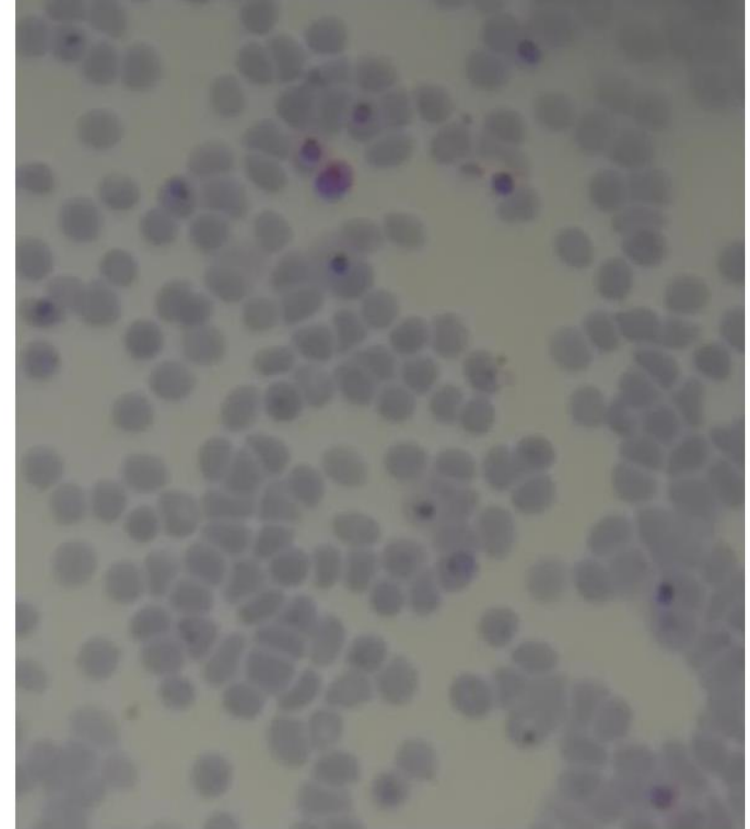
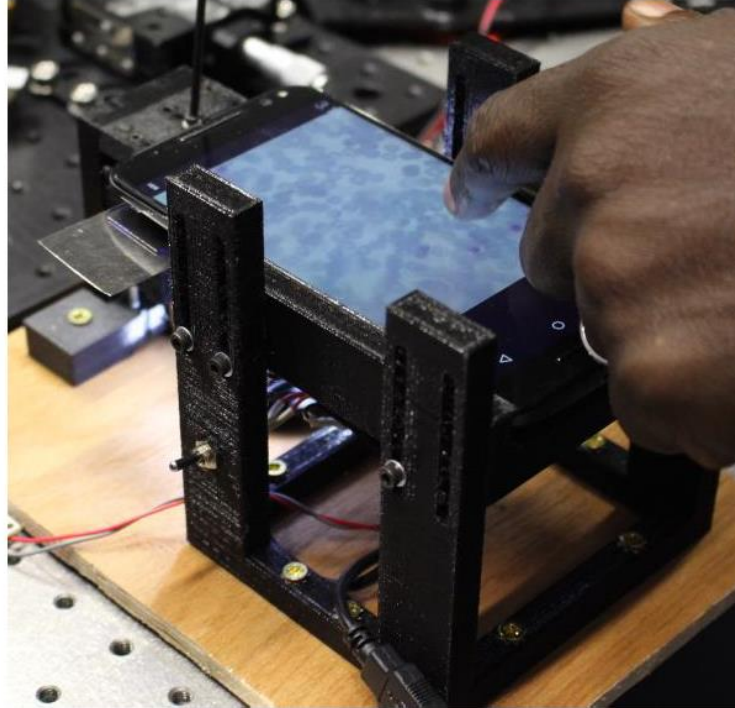
First steps in this direction

- Combined camera and wavefront sensor
- New use of old ideas



Gong, Agbana, *et al*, "Optical path difference microscopy with a Shack–Hartmann wavefront sensor," *Opt. Lett.* 42, 2122-2125 (2017)

Something completely different – Magic Camera



- Smartphone-based microscope
- Automatic diagnostics by a **non-specialist**

DCSC

Conclusions

My dream device:
high resolution, wide angle
image enhancer
which is as difficult to use as a pair of
spectacles

