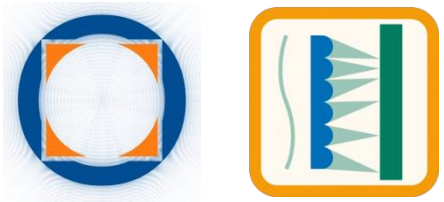
Measurement of the optical quality of windows and objective lenses using wavefront metrology

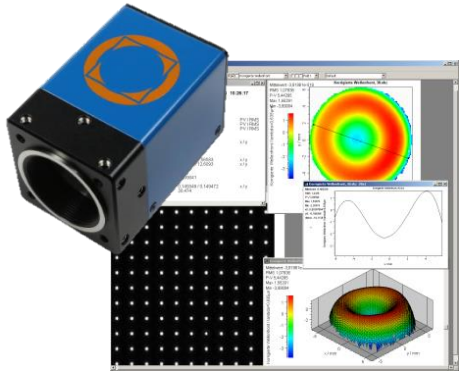
Dr. Christian Brock

Company Overview



Optocraft GmbH

Wavefront metrology for testing of Optics and Lasers



Shack-Hartmann wavefront sensors

Subsystems, Modules

Turnkey instruments

Optocraft GmbH

Basics

General

- Founded in 2001
- Located in Germany
- ISO9001:2015

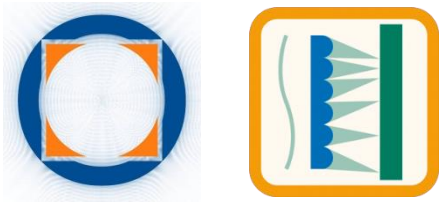
Strong team

- 35 employees

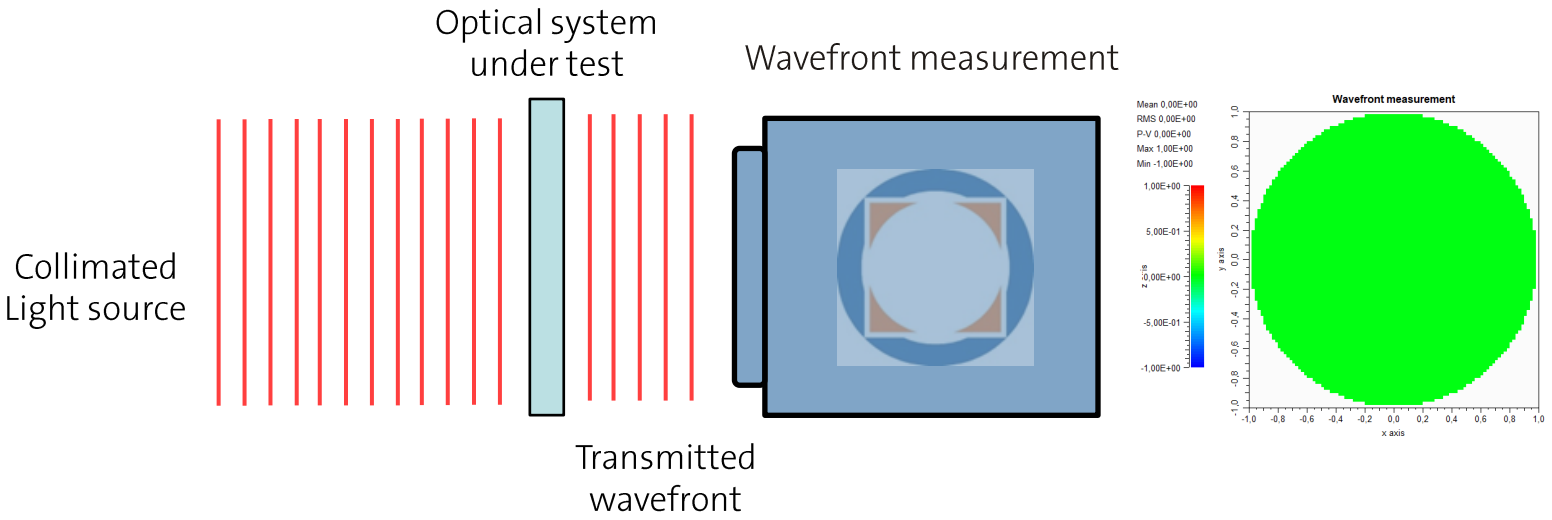
  Software, mechanical engineering, optical engineers, marketing/sales, finance, back office

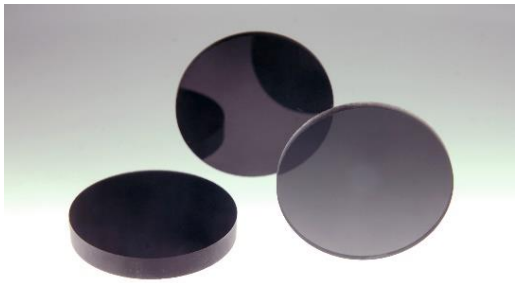
- Distributing partners in JP, UK, CN, S. Korea, Israel
- Since 2018: Partnership with µEpsilon

Testing of plano windows

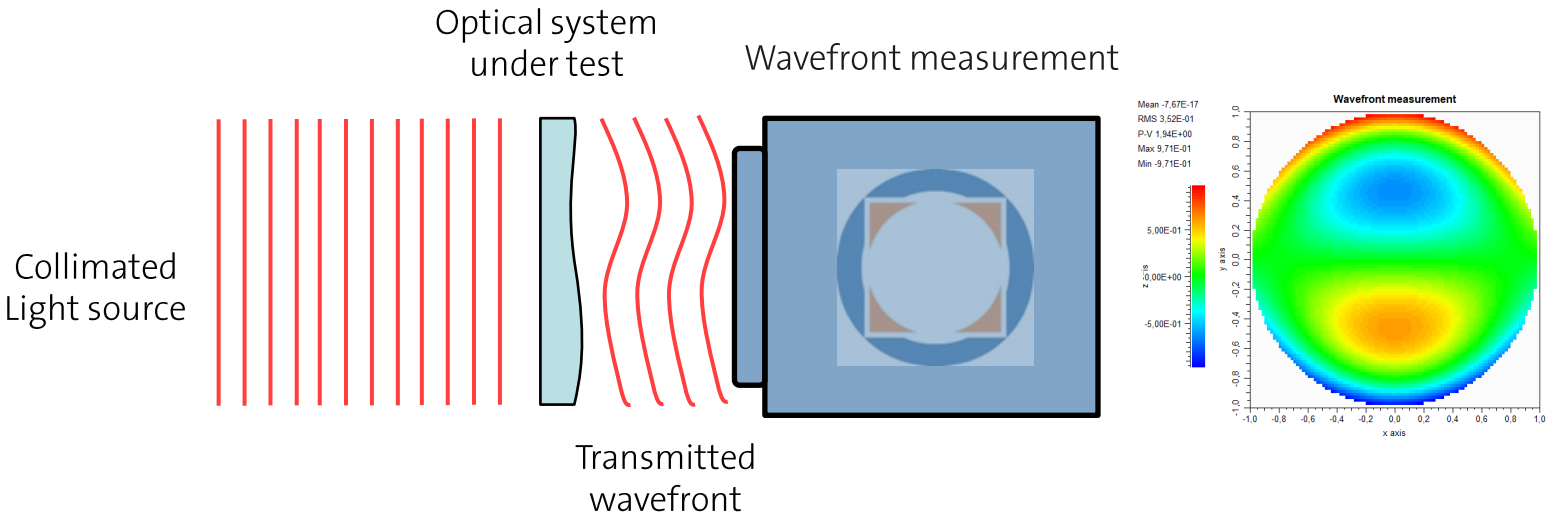


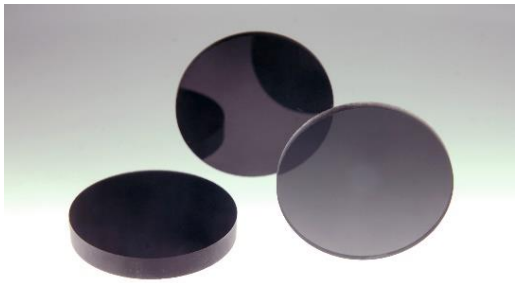
Testing of optical windows





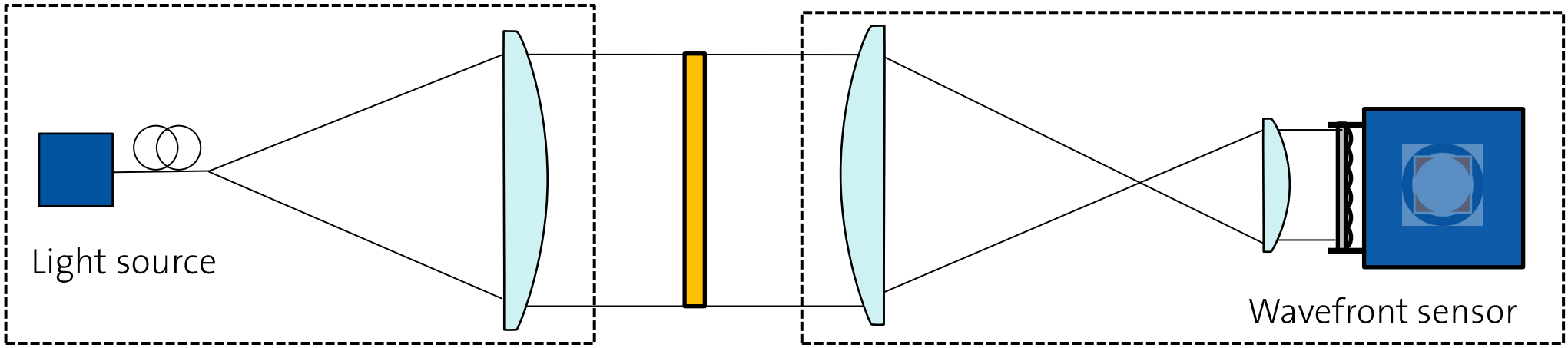
Testing of optical windows





Testing of optical windows

1Xpass configuration



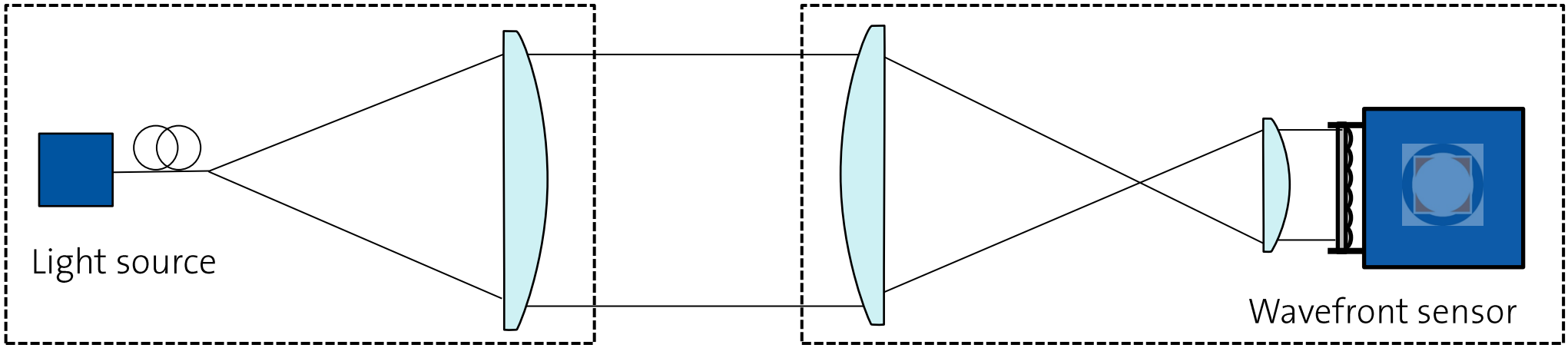
Illumination unit

Sample under test

Detection unit

Testing of optical windows

1Xpass configuration



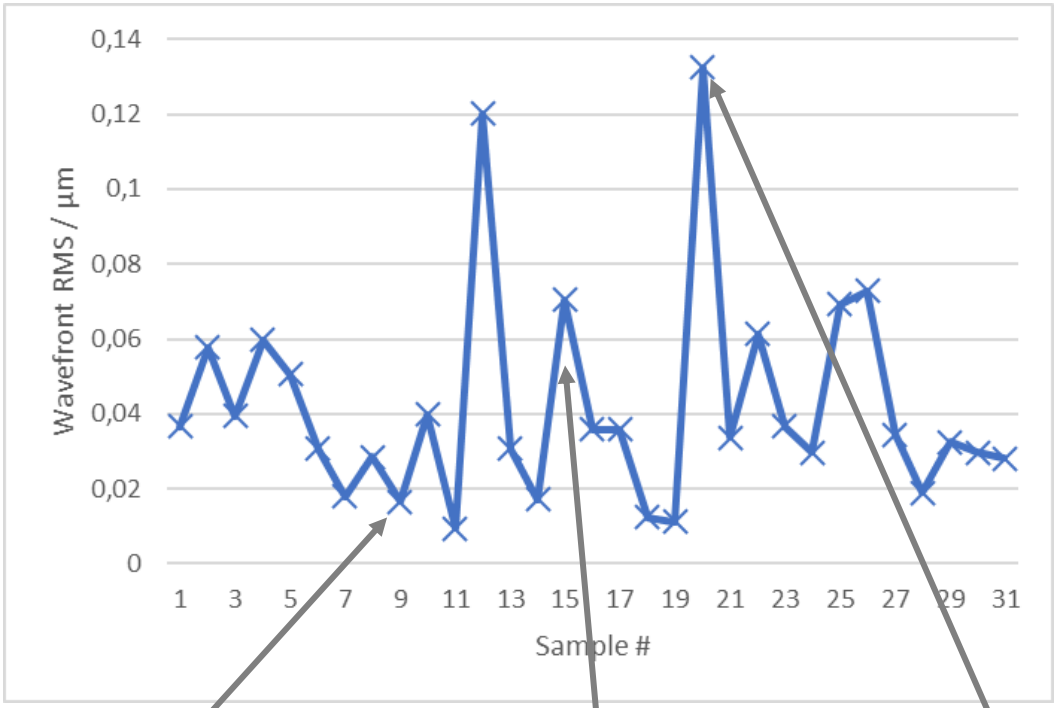
Illumination unit

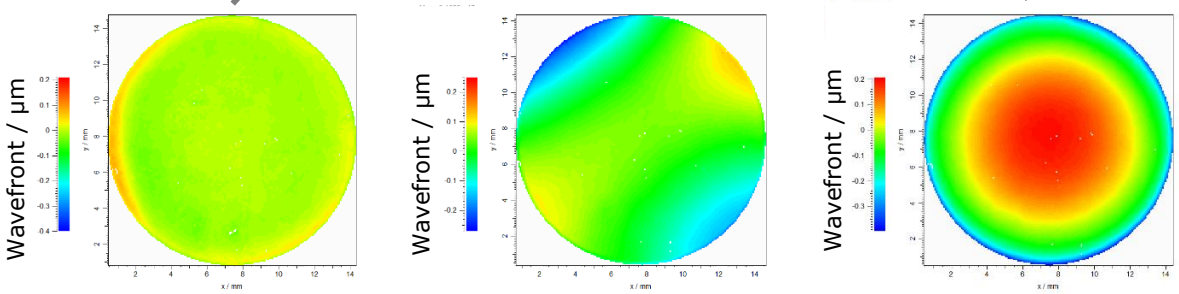
Detection unit

Simple reference measurement allows accuracy up to 2nm RMS!

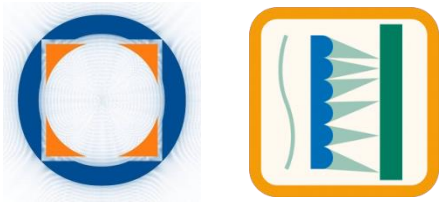
Testing of optical windows

Lot testing



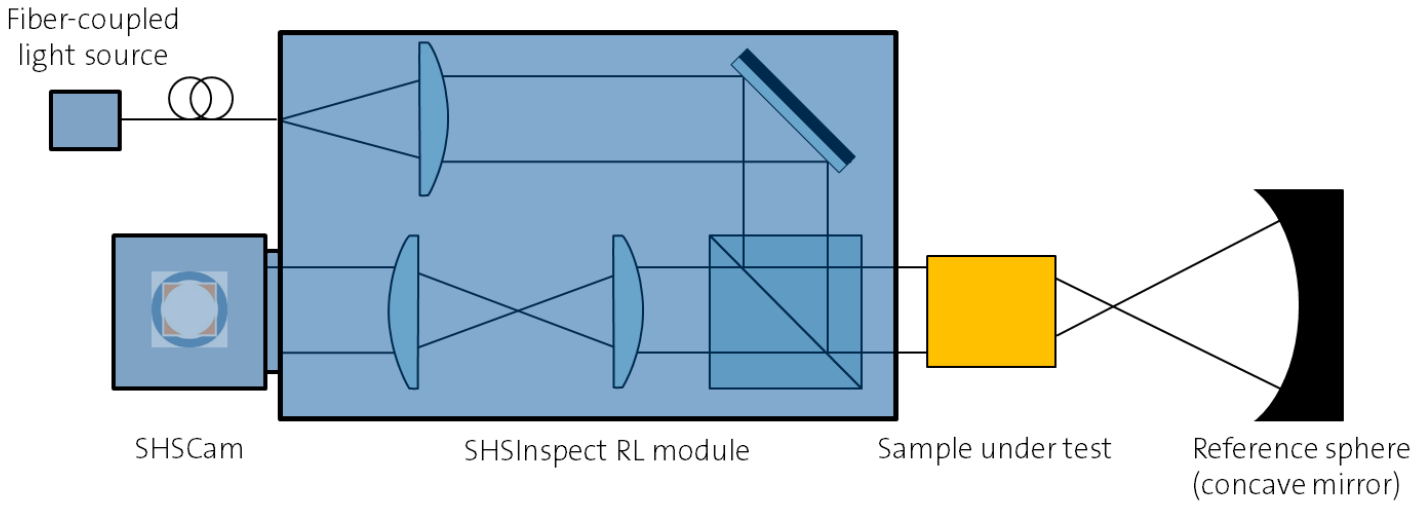


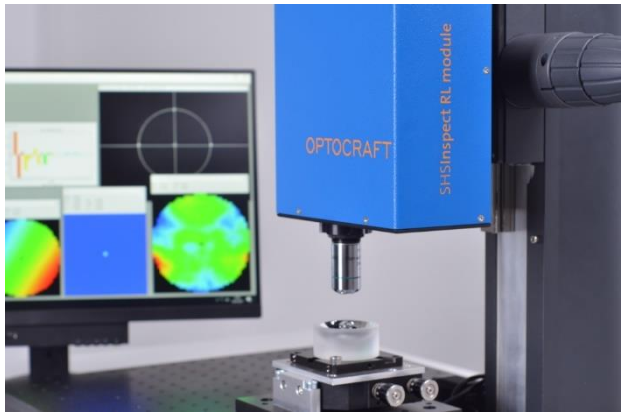
Objective lens testing



Objective lens testing

Double pass configuration

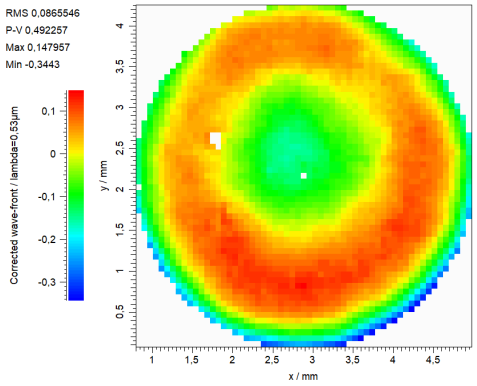




Objective lens testing

Measurement of 40X/NA0.65 microscope objective lens

Lens #1

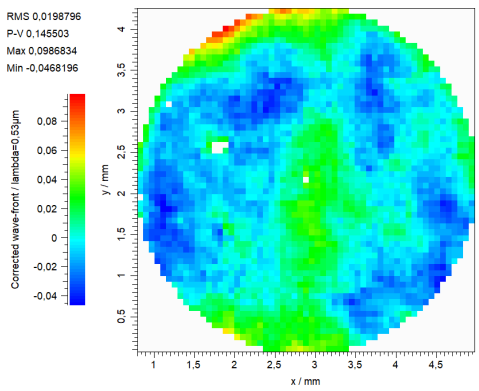


Strehl 0.75

Coma y 0.10
Sph. Ab. -0.14

Corr. wf. PV	0,492257
Corr. wf. RMS	0,0865546
Strehl ratio	0,747957
C0 piston	0,00645454
C1 tilt, x	-1,21026
C2 tilt, y	-0,198941
C3 defocus	0,050664
Ast. 0°, 1st	-0,00942035
Ast. 45°, 1st	0,00527726
Coma x	-0,0247589
Coma y	0,101805
Sph. ab.	-0,143868
trifoil 0°	0,0299979
0 trifoil 30°	-0,00816557
C11 Ast. 0°, 2nd	-0,0030715
C12 Ast. 45°, 2nd	-0,0061856
C13	-0,00163934
C14	0,00104578
C15 radial term	-0,00668285

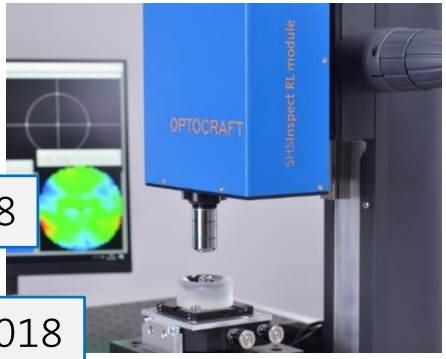
Lens #2



Strehl 0.98

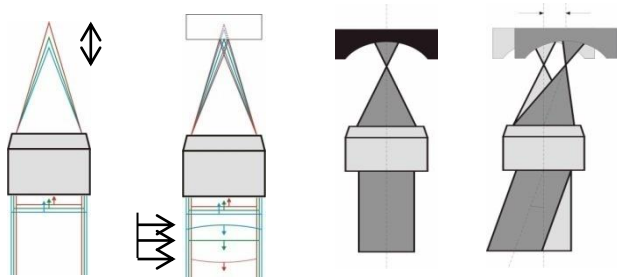
Coma y 0.018
Sph. Ab. 0.016

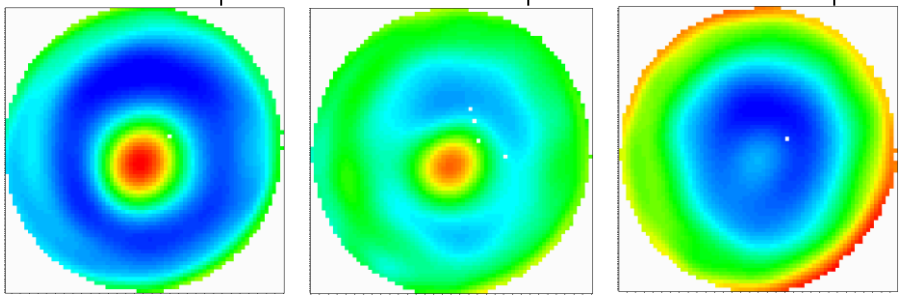
Corr. wf. PV	0,145503
Corr. wf. RMS	0,0198796
Strehl ratio	0,984543
C0 piston	-0,0009828
C1 tilt, x	0,243707
C2 tilt, y	0,368595
C3 defocus	-0,000856172
C4 Ast. 0°, 1st	-0,020971
C5 Ast. 45°, 1st	0,000661
C6 Coma x	-0,007841
C7 Coma y	0,018082
C8 Sph. ab.	0,016556
C9 trifoil 0°	0,016208
C10 trifoil 30°	0,008392
C11 Ast. 0°, 2nd	-0,00567251
C12 Ast. 45°, 2nd	-0,00342222
C13	0,00181017
C14	-0,00111103
C15 radial term	-0,000905469



Objective lens testing

Measurement of chromatic aberrations of a mobile phone lens





455nm
0.40 lambda pv

532nm
0.27 lambda pv

635nm
0.38 lambda pv

EPIC questions

What can Optocraft do for you?

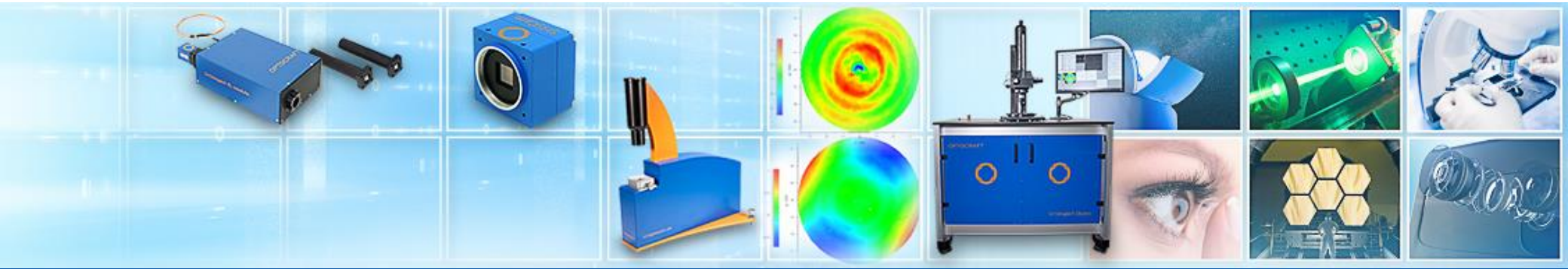
- Share expertise in optics testing
- Deliver solutions for optics testing
  (Wavefront sensors, modules, turn-key systems)

What can you do for Optocaft?

- Challenge us with your metrology application
- Provide special optics
- Provide special cameras

Optocrafts current challenges

- Measurement of large freeform optics
- Product modularisation

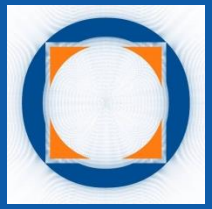


Know your quality -

Optical metrology made by Optocraft!

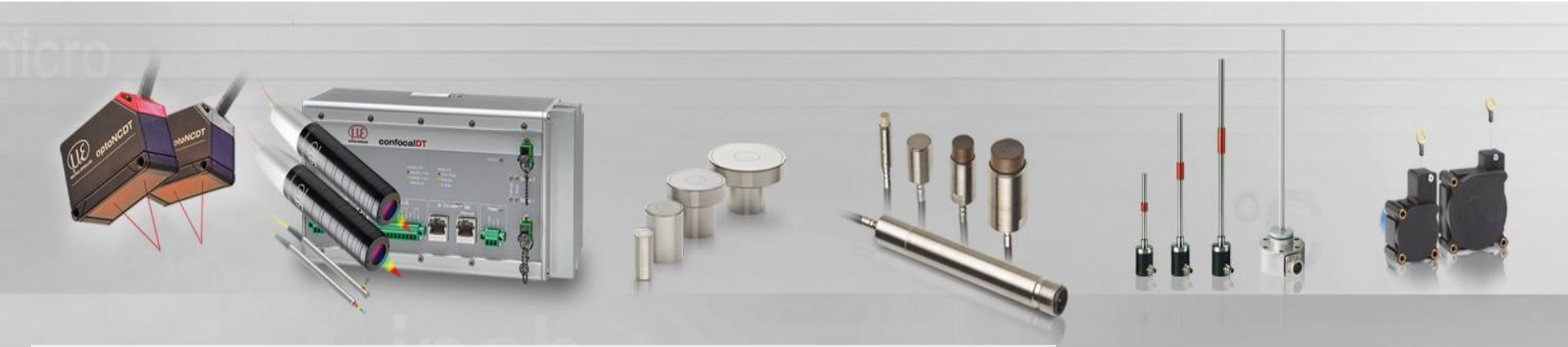
Contact:

sales@optocraft.de



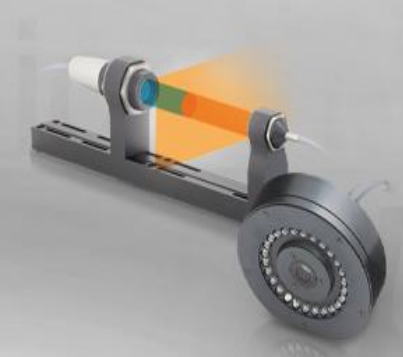
Micro-Epsilon Products

MICRO-EPSILON



Contactless distance sensors

Tactile distance sensors



Color Sensors

IR Temperature-Sensors

2D/3D Metrology Surface inspection

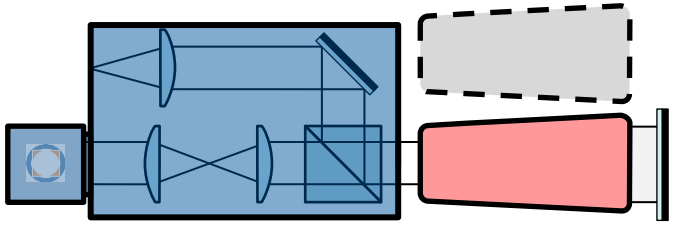
Measuring and inspection systems

SHSInspect RL module

Double pass configurations

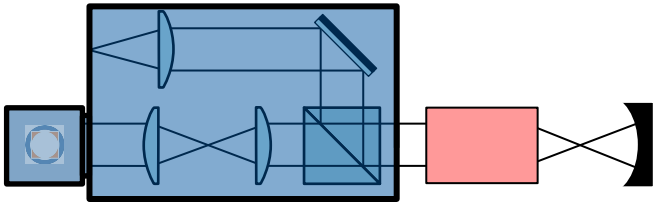
Infinite-infinite

Plano measurement beam
Reference flat
Filters, telescopes, binoculars



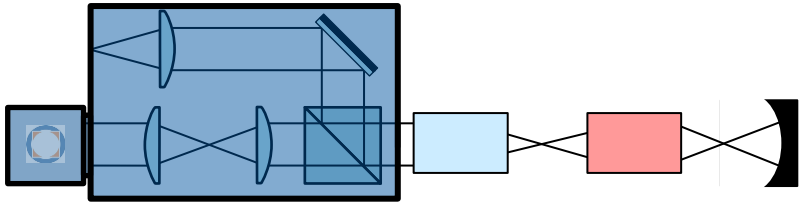
Finite-infinite 1

Plano measurement beam
Reference sphere
Objectives, lenses, sub-systems



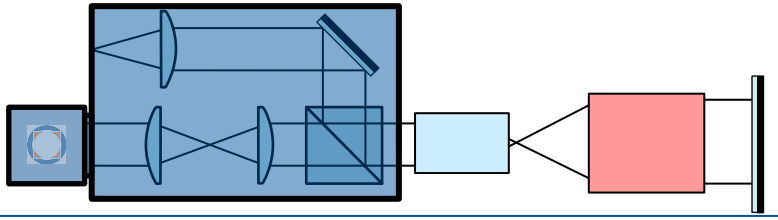
Finite-finite

Spherical measurement beam
Reference sphere
Objectives, lenses, sub-systems



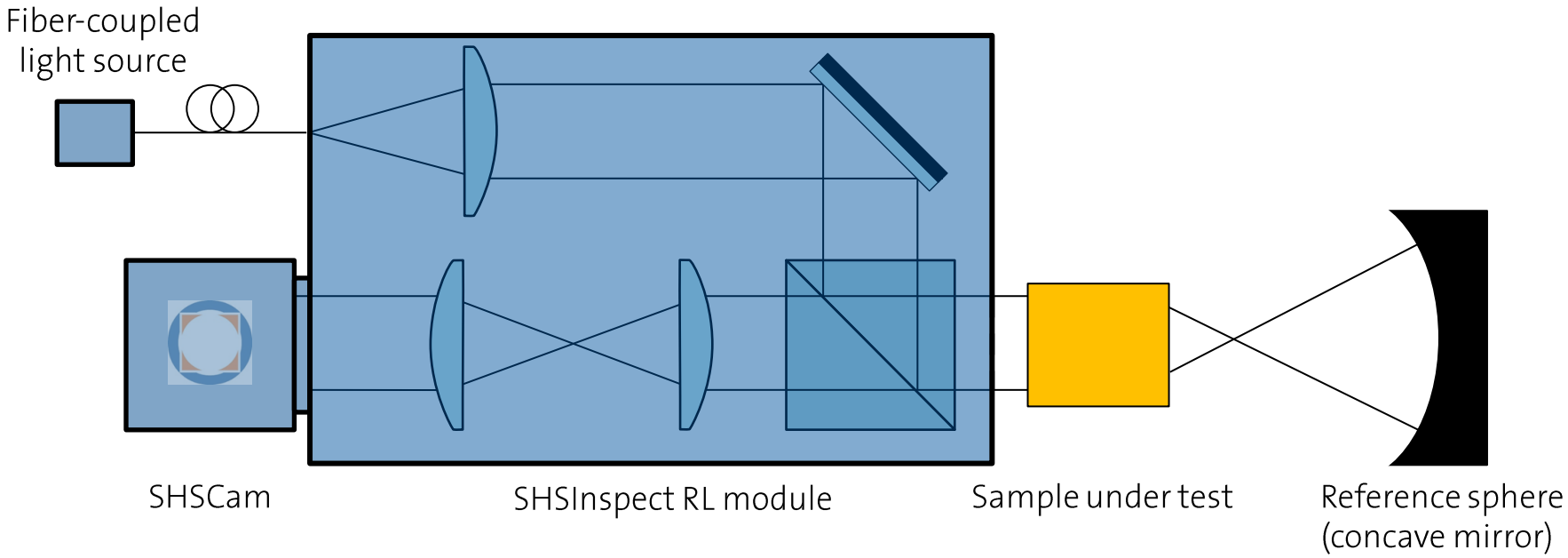
Finite-infinite 2

Spherical measurement beam
Reference flat
Objectives, lenses, sub-systems



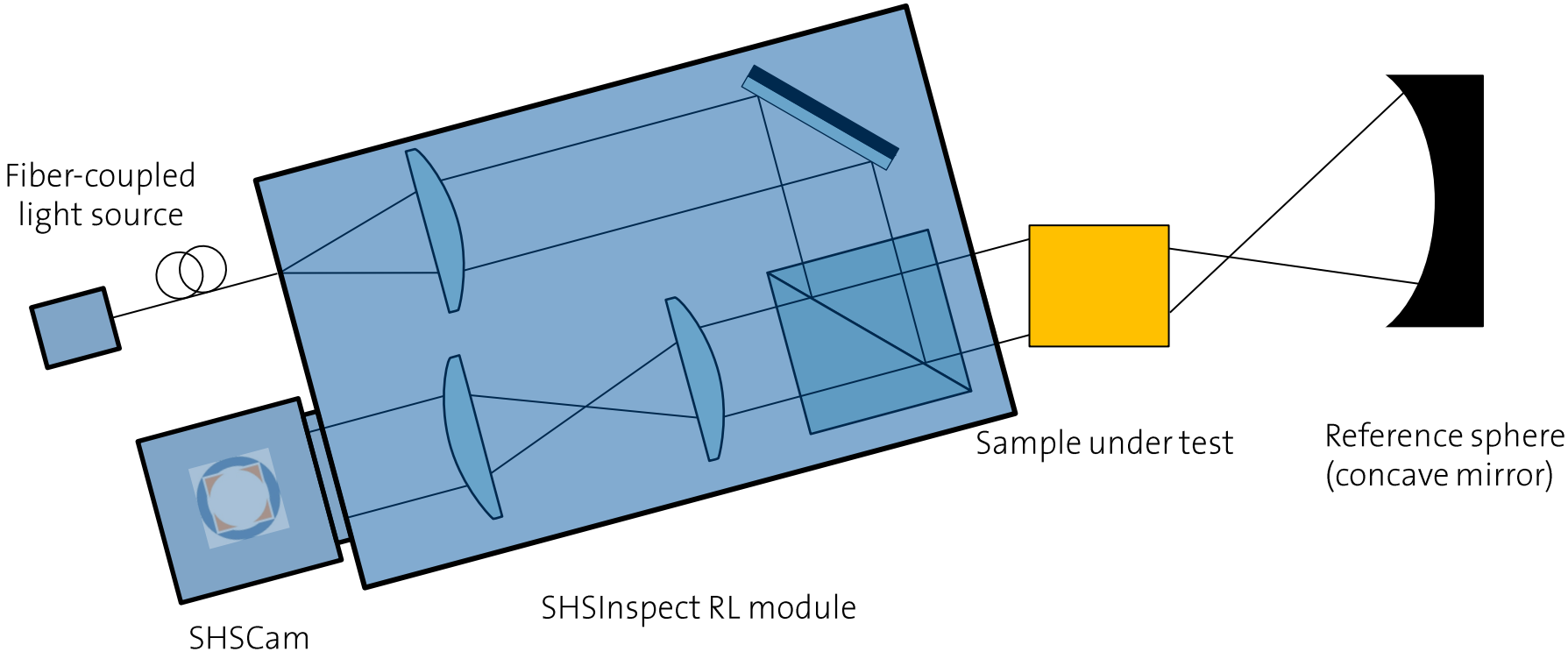
Optics testing in 2Xpass configuration

Finite-infinite configuration, off-axis measurement



Optics testing in 2Xpass configuration

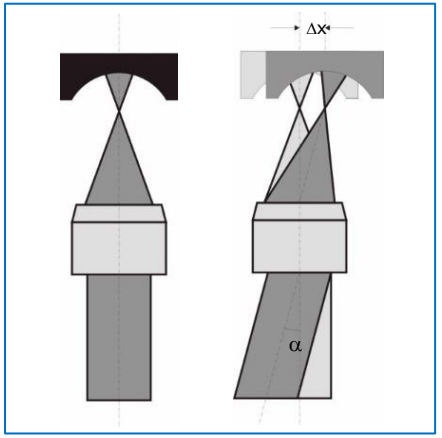
Finite-infinite configuration, off-axis measurement

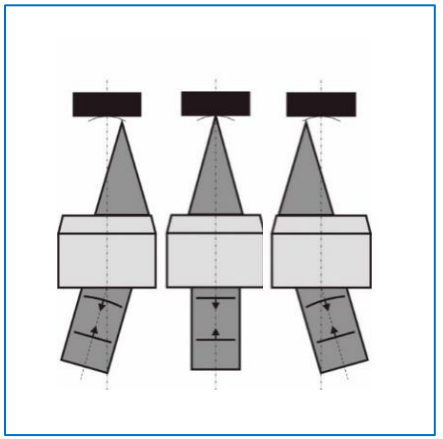


Objective lens Testing– SHSInspect 2Xpass

Measurement modi

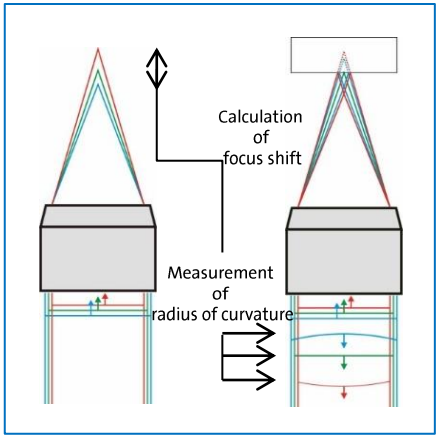
Field

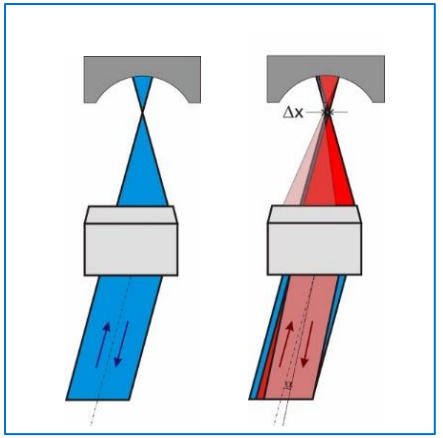




Field curvature

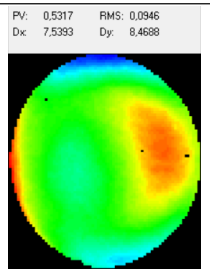
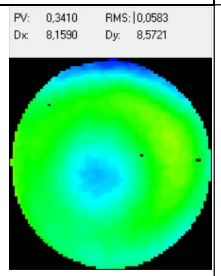
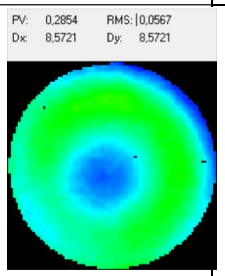
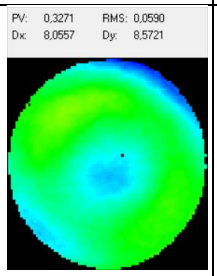
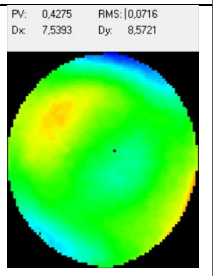
Axial chromatic aberration

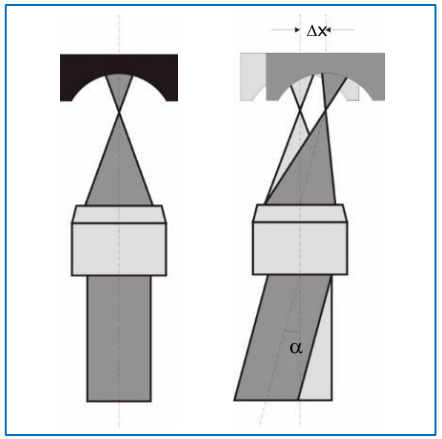


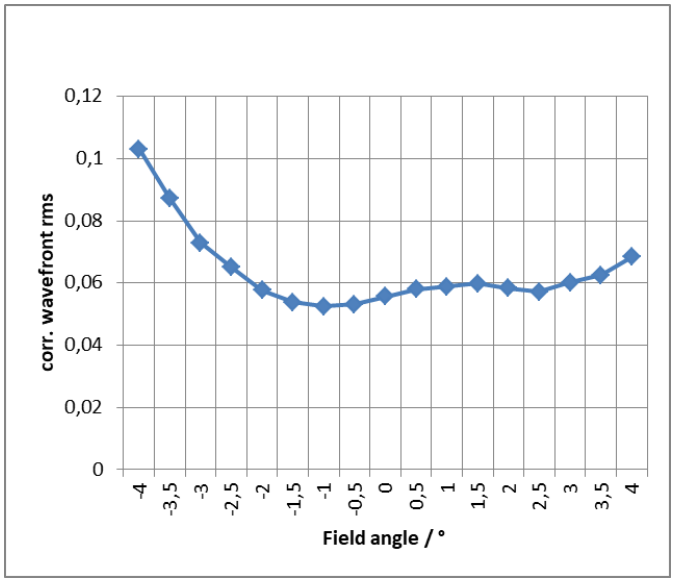


Lateral chromatic aberration

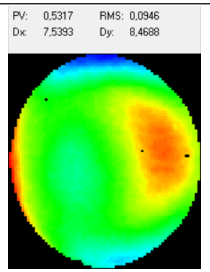
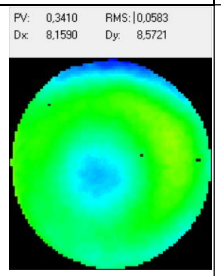
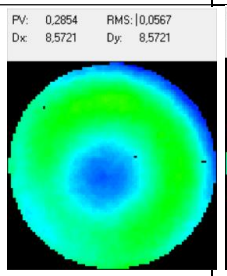
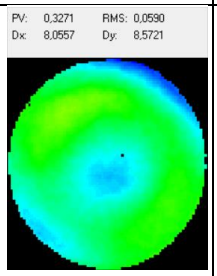
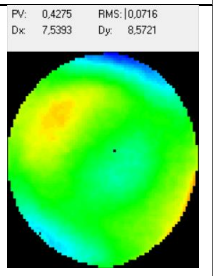
Microscope Objective lens – 10X

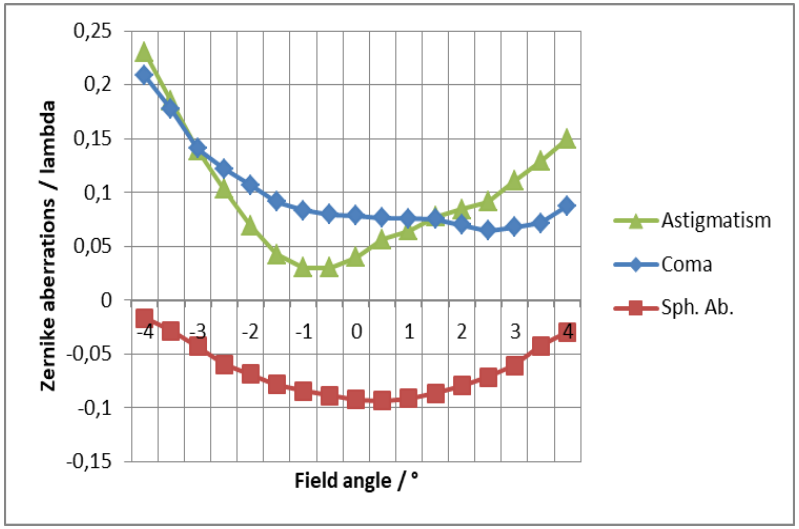
Field angle	-4°	-2°	0°	2°	4°
Corrected wavefront (635nm)					





Wave aberration analysis 10X lens

Field angle	-4°	-2°	0°	2°	4°
Corrected wavefront (635nm)					



Wave aberration analysis 10X lens

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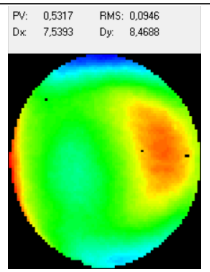
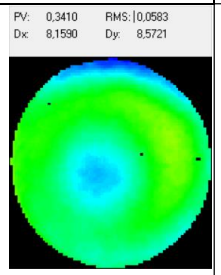
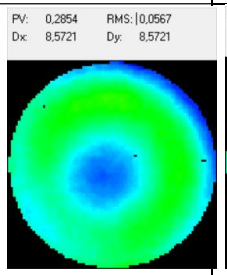
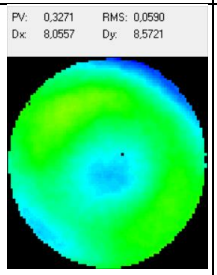
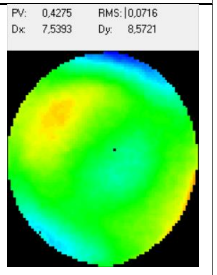
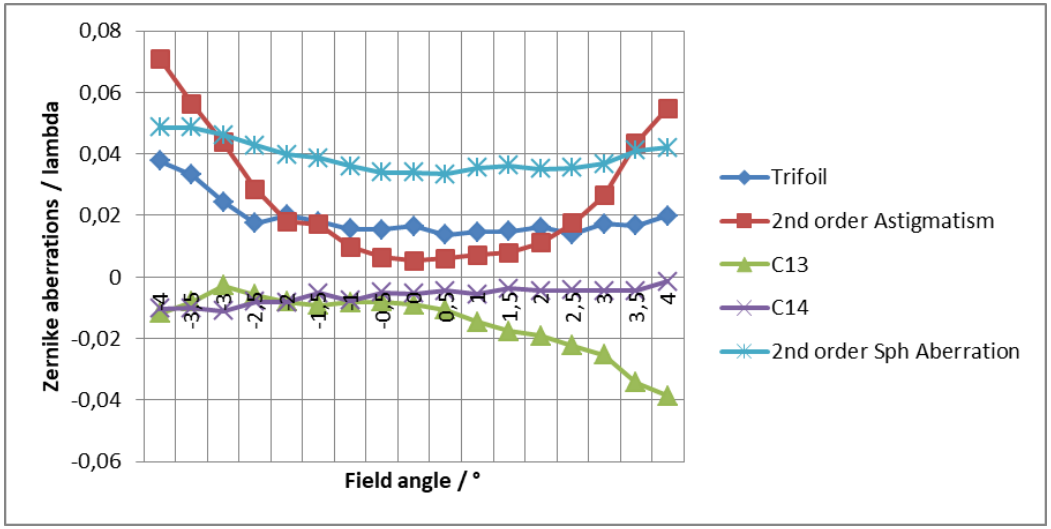
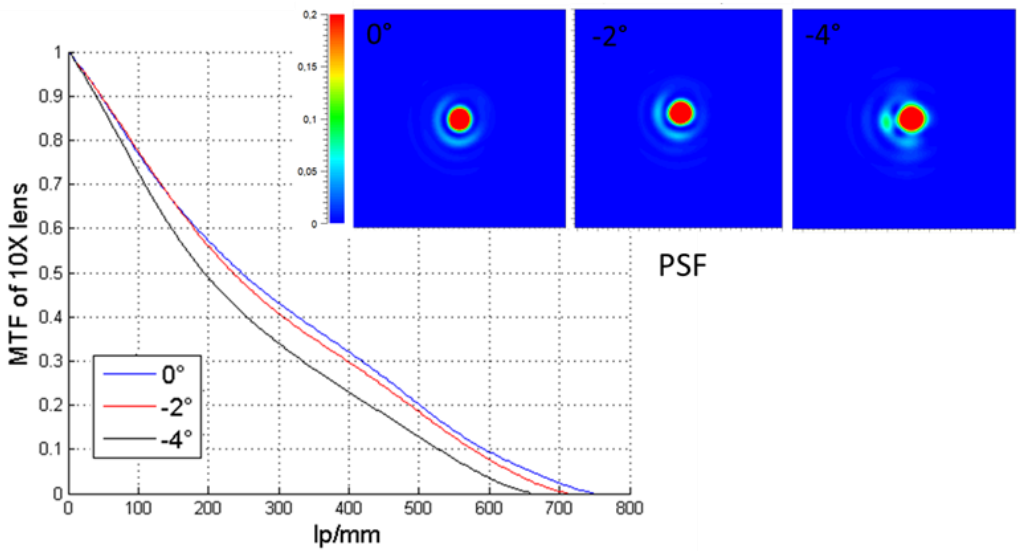
Corrected wavefront (635nm)					



PSF / MTF calculation



MTF and PSF for the 10X objective lens at 0°,-2° and -4° field angle