Image quality metrics for AO
(Visual impact of the combined correction of spherical and chromatic aberrations with AO)

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New LO·UM building!
spherical and chromatic aberrations are perhaps the most promising in practical terms...
...specially in the aging eye in cataract surgery with customized IOLs
Spherical Aberration and Age
Spherical Aberration and Age

Chromatic Aberration

Quite significant: >1.5 D (although with limited impact) and stable through age.
What is the visual benefit of correcting SA with IOLs?

What is the optimal residual value of SA?
What is the visual benefit (if any) of correcting CA?

What is the visual benefit of the combined correction of SA and CA?
We used Adaptive Optics trying to answer these questions
Visual acuity and/or contrast sensitivity tests

LO·UM_AO_instrument with a 97-elements Xinetics deformable mirror
We measured CS (12 c/deg) for:
4 SA values and 5 defocus positions
with:
1) Astigmatism corrected
2) All high-order aberrations corrected
5.5 mm mode B (Fully corrected)

...and induce the required SA!
Astigmatism corrected

Average data (5 subjects)

SA ($\mu$m)

-0.09  0  +0.09  +0.0

Defocus (D)

-0.6  -0.4  -0.2  0.0  0.2  0.4  0.6

SA (µm)

Average data (5 subjects)
ALL corrected

Average data (5 subjects)

SA (µm)

Average Defocus (D)

-0.6 -0.4 -0.2 0.0 0.2 0.4 0.6

-0.09 0 +0.09 +0.0
Correcting CA

Phase plate correcting LCA
Correcting CA

WATER

CORRECTOR

PLANO-PARALLEL PLATE

10 µm
Measuring LCA: white-light HS sensor

- H-S sensor
- Achromatizer plate
- White-light lamp
- Interference filter
LCA after correction

- Wavelength (nm)
  - 400
  - 500
  - 600
  - 700

- Defocus (D)
  - -1.5
  - -1.0
  - -0.5
  - 0.0
  - 0.5
  - 1.0
  - 1.5

- Chromatic eye

- LCA after correction

- PA
- SM
- HW
- Chromatic eye
Visual testing after LCA & SA correction
We measured CS & Visual acuity for: 2 SA values (0 & 0.15 µm) and 2 CA states

... in white light
VA after SA & CA correction

Average

1.6
1.2
0.8
0.4
0.0
VA after SA & CA correction

Average

Visual acuity
0.0
0.4
0.8
1.2
1.6

10 um
VA after SA & CA correction

Average

1.6
1.2
0.8
0.4
0.0

Visual acuity

VA after SA & CA correction
VA after SA & CA correction
CS after SA & CA correction

Average
CS after SA & CA correction
CS after SA & CA correction
CS after SA & CA correction

Average

\[ 40\% \]
i) Correcting all SA present in the eye provides the best visual performance (without compromising depth of focus)

ii) Correcting CA improves VA and CS in white light
iii) The combined correction of both SA and CA could improve spatial vision by around 40% in average.

iv) Using Adaptive Optics is a powerful tool to state the limits in visual benefit after aberration correction.
v) These results suggest a potential and significant benefit of combined aspheric and acromatizing IOLs.
Thank you for your attention,

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