

Preface

The Tenth International Workshop on Adaptive Optics for Industry and Medicine took place in Padova, Italy from June 15-19, 2015. The meeting was attended by about 100 participants. The meeting also had a one day Adaptive Optics School on June 15 and a small exhibition with 14 companies participating. The Workshop is at the tenth edition and follows the ones held in: Shatura (Russia, 1997), Durham (UK), Albuquerque (USA), Muenster (Germany), Beijing (China), Galway (Ireland), Shatura (Russia), Murcia (Spain) and Cape Town (South Africa).

Adaptive Optics started its diffusion in astronomy in the late 80s thanks to its capability to improve the image quality of terrestrial telescopes. Since then Adaptive Optics has been developing and nowadays is successfully used in many scientific and industrial applications. In the last few years, adaptive optics has been rapidly changing thanks to the introduction of adaptive lenses, new control strategies and integrated fast electronics that have made adaptive optics compact, more practical and cheaper. The impact of these advancements can be observed by the presence of many companies at this workshop and by their product line that is not limited to devices but extended to complete systems oriented to specific applications. Microscopy, ophthalmology, high power laser systems and other new applications can now exploit adaptive optics at a reasonable price.

The organization of an international Workshop is an important honor and at the same time a big effort. I would like to express my deep gratitude to the scientific committee for choosing Padova for the organization of this Workshop and for its support: Pablo Artal, Chris Dainty, Andrew Forbes, Alexis Kudryashov, Gordon Love, Sergio Restaino, and Ulrich Wittrock. I would also like to remember the invaluable assistance of the local committee, Sandra Perazin, Cinzia Di Celmo and Gianluca Rossi and my students who served as volunteers Gianluca Dalle Rive, Chiara Nardin and Carlo Rigoni.

The Workshop took place in the beautiful Sala Paladin of the Padova City Hall thanks to the support of the Padova city council.

In addition, I would like to remark the importance of the participation of our sponsors that gave us financial support: ONRG (Office of Naval Research Global), Alpao, Phasics, Boston Micromachines, Iris AO, Spot Optics, NightN, Hilase, Thorlabs, Fraunhofer IOF, Voptica, Pecchioli Research, Light Trans, Holoeye, Adaptica and Optocraft. The Workshop was also supported by Galileo Scientific Park, VIMM Foundation for Advanced

Biomedic Research, Italian Society of Optics and Photonics and EPIC
European Photonics and Industry Consortium.

I hope that many people reading this proceeding will participate to the next
AOIM Workshop.

Stefano Bonora

Padova, June 2015

Contents

Preface.....	i
Part 1: Wavefront Sensing.....	1
Large and Extremely Large: Field of View and telescope sizes in AO for Astronomy	
<i>R.Ragazzoni</i>	3
Measuring the wavefront and phase of structured light with spatial light modulators	
<i>A.Forbes, A.Dudley, G.Milione and R.Alfano</i>	6
Wavefront Sensing and Analysis for Underwater Laser Propagation	
<i>S.R. Restaino, Hou W., A.Kanaev, S.Matt, C.Font</i>	9
Hartmannometer versus Fizeau Interferometer: advantages and drawbacks	
<i>A.Nikitin, J.Sheldakova, A.Kudryashov, D.Denisov, V.Karasik,</i> <i>A.Sakharov</i>	13
Intensity-based Wavefront Sensing employing Surface Plasmon Polaritons	
<i>B.Vohnsen, D.Valente</i>	16
Realization of an analogue holographic wavefront sensor	
<i>A.Zepp, S.Gladysz, R.Barros, K.Stein, W.Osten</i>	20
Holographic Wavefront Sensors	
<i>V.Venediktov, M.Soloviev</i>	25
Liquid-filled photonic crystal fiber as wavefront sensor	
<i>D.Valente, D.Rativa and B.Vohnsen</i>	27
Curvature sensing with a Shack-Hartmann sensor	
<i>O.Soloviev, M.Verhaegen, G.Vdovin</i>	31

Improved Thresholding and Ordering for Shack-Hartmann wavefront sensors implemented on an FPGA	
<i>S.Mauch, A.Bartha, J.Regera, N.Leonhard, C.Reinlein</i>	35
Least Squares Fitting of Hartmann or Shack-Hartmann Data with a Circular Array of Sampling Points	
<i>D.Malacara-Doblado, Z.Malacara-Hernández and D.Malacara-Hernández</i>	40
Hologram recording and reconstruction using Shack–Hartmann sensor and spatial light modulator	
<i>V.Yu.Venediktov, A.Gorelaya, A.A.Sevrygin, V.P.Lukin</i>	46
Wave-Front Sensing Library with CPU and GPU	
<i>S.Choi, S.Yu, J.Kim, T.Keun Kim, J.Lee, K.Cho, and H.Lim</i>	49
Part 2: Refractive wavefront modulators	53
Fourier phase unwrapping in a digital phase shifting point diffraction interferometer	
<i>V.Akondi, C.Falldorf, S.Marcos, B. Vohnsen</i>	55
Active Light Shaping using GPC	
<i>J. Glückstad, D. Palima, M. Villangca and A. Bañas</i>	59
Improving the performance of LCOS spatial light modulators for adaptive optics applications	
<i>G.Lazarev</i>	63
Adaptive Polymer Lens development for applications in the VIS-SWIR-MWIR	
<i>F.Santiago, B.Bagwell, V.Pinon III and S.Restaino</i>	67
Part 3: Ophthalmology and vision	71
How can we get several billion people in the world to see with 20/20 Vision	
<i>J.Silver</i>	73

Wavefront sensorless adaptive optics optical coherence tomography for retinal imaging in mice and in humans	
<i>M.V.Sarunic, Y.Jian, K.Wong, M.Gradowski, D.Wahl, S.Bonora, R.J.Zawadzki</i>	79
High resolution imaging using adaptive optics assisted SLO/ OCT	
<i>M.Pircher, M.Rechenmacher, F.Felberer, R.Haindl, B.Baumann, and C.K.Hitzenberger</i>	83
Microscope-integrated optical coherence tomography with a head-up display for glaucoma surgery	
<i>X.Li, P.Huang, Y.He, L.Wei, G.Shi and Y.Zhang</i>	87
A fractal eye model to predict the wide-angle PSF	
<i>A.Arias, H.Ginis and P.Artal</i>	91
Simulating vision correction methods with adaptive optics	
<i>M.F.Coughlan, A.Goncharov</i>	94
Optimal template location for retinal motion extraction using cross-correlation with a line scanning ophthalmoscope	
<i>Y.He, X.Li, Z.Wang, L.Wei, G.Shi, Y.Zhang</i>	98
Advanced Eye Refraction and Visual Testing with Liquid Crystal-based Adaptive Optics Technology	
<i>E.J.Fernández, P.M.Prieto, B.Jaeken, L.Hervella, G.M.Pérez, P.Artal</i>	102
Part 4: Control	107
Aberrations: Effect of the reference point	
<i>C.J. R. Sheppard</i>	109
Discretized aperture mapping: a low-pass spatial filter in optics	
<i>F.Patru, J.Antichi</i>	113
Deformable mirrors for Quantum Optics applications	
<i>G. Vallone, S. Bonora, M.Minozzi, A.V.Sergienko, C.Bonato, A.Chiuri, P.Mataloni, P.Villoresi</i>	117

Feedforward Operation of a Lens Setup for Large Defocus and Astigmatism Correction	
<i>H.R.G.W. Verstraete, R.Bilderbeek, J.Kalkman, and M.Verhaegen</i>	122
Part 5: Wavefront modulators	127
Sound driven optofluidic lenses for high-speed focusing	
<i>M.Duocastella</i>	129
Small-Aperture Unimorph Deformable Mirror for Laser Applications	
<i>P.Rausch, S.Verpoort, and U.Wittrock</i>	133
Materials choice as a new route to Photoconductive deformable mirrors of large dimension	
<i>M.Quintavalla, S.Bonora, A.Bianco, D.Natali</i>	137
Large aperture photocontrolled deformable mirror based on Zinc Selenide	
<i>M.Quintavalla, S.Bonora, A.Bianco</i>	140
Electrically tuneable lenses made of electromechanically active polymers	
<i>F.Carpi, M.Pieroni, C.Lagomarsini and D.Rossi</i>	143
Performance Verification and Environmental Testing of a Unimorph Deformable Mirror for Space Applications	
<i>S.Verpoort, P.Rausch, and U.Wittrock</i>	147
Concept of a large unimorph deformable mirror with a compliant mounting structure	
<i>M.Goy, C.Reinlein</i>	151
Large contactless adaptive mirrors technology: status and perspectives	
<i>R.Biasi</i>	155
Part 6: Microscopy	159
Multiphoton Imaging with Wavefront Sensorless Adaptive Optics	
<i>J.M. Bueno, G.Hernández, M.Skorsetz, P.Artal</i>	161
Spatial Light Modulation Two Photon Microscopy for High Frequency Functional Imaging	
<i>P.Pozzi, D.Gandolfi, M.Tognolina, G.Chirico, J.Mapelli, E.D'Angelo</i>	164

Optimization-based light-sheet generation	
<i>D.Wilding, P.Pozzi, O.Soloviev, G.Vdovin and M.Verhaegen</i>	167
Adaptive optics for super-resolution nanoscopy	
<i>M.J.Booth</i>	170
Conjugate Adaptive Optics in Microscopy with Partitioned Aperture Wavefront Sensing	
<i>D.Beaulieu, J.Li, T.Bifano, J. Mertz</i>	174
Tissue Tomographic Phase Image Contrast Improvement with Adaptive Optics	
<i>S.Aknoun, I.Doudet, P.Bon, B.Wattellier, S. Monneret</i>	178
Comparison of a Multi-actuator Adaptive Lens with deformable mirrors and its application in in-vivo imaging	
<i>ABertolucci, Y.Jian, Y.Saitashev, L.Rizzotto, P.Zhang, E.N.Pugh, Jr., M.Dantus, F.Mammano, R.J.Zawadzki, M.V.Sarunic, S.Bonora</i>	180
Part 7: High power lasers	185
Wide Aperture Adaptive Optics for high Power CO ₂ Laser Beam Control	
<i>A.Alexandrov, A.Kudryashov, A.Rukosuev, V.Samarkin</i>	187
Adaptive optics systems deployed on a 100J, 10 Hz cryogenic cooled amplifier system	
<i>J.Smith, J.Phillips, C.Hooker, K.Ertel, P.Mason, S.Banerjee, T.Butcher, M.De Vido, J.Pilar, S.Bonora, J.Greenhalgh, C.Edwards, C.Hernandez- Gomez, J.Collier</i>	191
Optics loop implementation and optimization for petawatt laser	
<i>I.Doudet, B.Wattellier</i>	194
Adaptive optics system for HiLASE high average-power multi-slab laser system	
<i>J.Pilar, S.Bonora, O.Slezak, M.Sawicka-Chyla, M.Divoky, J.Phillips, J.Smith, K.Ertel, J.Collier, H.Jelinkova, A.Lucianetti and T.Mocek</i>	197

Beam shaping of femtosecond pulses with diffractive optical elements: spatio-spectral and temporal dynamics <i>R.Borrego-Varillas, B.Alonso, J.Perez-Vizcaino, I.Gallardo-Gonzalez, G.Minguez-Vega, O.Mendoza-Yero, J.Lancis, A.Forbes and I.J.Sola...</i>	201
Adaptive Optics for ultrashort pulse manipulation <i>A.Cantaluppi, S.Bonora, G.Cerullo and C.Manzoni.....</i>	205
Pulse front adaptive optics: a new method for control of ultrashort laser pulses <i>B.Sun, P.Salter and M.Booth</i>	209
Doughnut-like and Super-Gaussian Beam Formation in Closed-loop with Shack-Hartmann wavefront sensor <i>J.Sheldakova, A.Lylova, A.Kudryashov, V.Samarkin.....</i>	213
Part 8: AO systems	217
Optical field reconstruction with digital micromirror interferometry <i>H.Gong, P.Pozzi, O.Soloviev., M.Verhaegen, G.Vdovin.....</i>	219
Dynamic properties of adaptive optics systems <i>V.P.Lukin, L.V.Antoshkin, V.V.Lavrinov, L.N.Lavrinova.....</i>	223
Applications of adaptive fiber optics collimators for laser beam combining and propagation through atmosphere turbulence <i>X.Li, C.Geng, Y.Tan, H.Liu, F.Li and Y.Yang.....</i>	228
Development of a CPU-based architecture for high performance adaptive optics systems <i>J.Mocci, S.Bonora, R.Muradore</i>	233
Development of a scalable generic AO kernel for the next generation of ELTs <i>A.Surendran, M.P.Burse, A.N.Ramaprakash, P.Parihar.....</i>	237
Fiber optic gyroscopes based on photonic crystal fibers <i>H.A. Muse.....</i>	240

Multilayer adaptive optics development for the EUV wavefront control <i>M.Miszczak, S.Bonora, A.J.Corso, P.Zuppella, D.Bacco, A.Donazzan, Z.Wang, P.Nicolosi, W.S.Brocklesby, M.G.Pelizzo</i>	245
Numerical Simulation of LGS Propagation and Extended Spot Effect in Adaptive Optics for Atmospheric Turbulence Correction <i>X.Luo, X.Li, L.Shao, S.Hu, K.Huang</i>	249
Active Optics for space applications: developments at ESA <i>P.Hallibert, A.Zuccaro Marchi</i>	253
Part 9: Propagation and turbulence	257
Artificial Atmospheric Beamlet as a Test-Bed for Adaptive Optics <i>V.Venediktov, A.Gorelaya, E.Shubenkova, D.Dmitriev, I.Lovchiy, A.Tsvetkov</i>	259
Low Cost Adaptive Optics Testbed for Small Aperture Telescopes <i>M.Cegarra Polo and A.Lambert</i>	263
Holographic Adaptive Laser Optics System (HALOS) <i>G.Andersen, P.Gaddipati, R.Gaddipati</i>	267
Atmospheric Distortion of Multichannel Laser Radiation and Correction for Distortion <i>V.Lukin, O.Antipov, F.Kanev, and N.Makenova</i>	270