Ronald H. Silverman, PhD

Professor of Ophthalmic Science (in Ophthalmology)

Dr. Silverman has been involved in ultrasound research in ophthalmology for 30 years. His research includes development of high-resolution imaging systems, studies of ultrasound safety and bioeffects, high-intensity ultrasound, blood-flow imaging, photoacoustics, and tissue characterization by use of signal-processing. He applies these techniques for studies of ocular disease in animal models and for clinical examinations.

Dr. Silverman is currently Principle Investigator on an NIH-sponsored project whose goal is development of a novel ultrasonic imaging technique, ultrafast plane-wave imaging, which enables acquisition of up to 10,000 images per second. Computer-analysis of the data allows visualization and measurement of blood-flow throughout the eye and orbit. This technique is being applied to glaucoma, vascular malformations and occlusions. Collaborators on this project include Raksha Urs, PhD, Jeffrey Ketterling, PhD (Riverside Research) and Alfred Yu, PhD (University of Waterloo).

He is also collaborating with Riverside Research scientists Jonathan Mamou, PhD and Daniel Rohrbach, PhD on a novel method called scanning acoustic microscopy for imaging and characterizing tissue sections. This method utilizes ultrasound probes with frequencies of 250-500 MHz, 10x higher than that used for clinical imaging of the eye, to produce image detail comparable to light microscopy, but more importantly, information about the physical properties of the tissue, including elasticity and density. Dr. Silverman is using this system to assess the cornea, sclera and optic nerve in keratoconus, myopia and glaucoma.

Dr. Silverman has numerous patents and was a co-founder of Ultralink, LLC, which, under license from Cornell University, developed the Artemis ultrasound system for imaging and biometric analysis of the cornea and anterior segment. Ultralink has since been acquired by Arcscan, Inc., which is further developing the technology.

Dr. Silverman is active in several professional organizations. He served on the ARVO Program Committee, Anatomy & Pathology Section, from 2008-2011 and is currently on the program committee of the ARVO Imaging in the Eye Conference. He is also on the program committee and a co-organizer of the International Conference on Ultrasonic Biomedical Microscanning. He is a Fellow of the Association for Research in Vision and Ophthalmology (FARVO), the American Institute of Ultrasound in Medicine (FAIUM), the American Institute of Medical and Biological Engineers (FAIMBE) and is a Senior Member of the IEEE.

Aside from presenting and moderating at numerous meetings, Dr. Silverman has also often acted as an organizer for special sections. He is frequently asked to review articles in journals specializing in ophthalmology, ultrasound and optics. In addition, he serves as a grant-reviewer for the NIH.

Dr. Silverman has mentored and trained numerous students, fellows, and residents that have worked in his laboratory over the years and considers this an important aspect of his work.

Since 2012, Dr. Silverman has been Director of the Basic Science Course in Ophthalmology (BSCO) which has been offered by Columbia University for over 75 years. With the able assistance of Stephen Tsang, MD, PhD (co-director), Harriet Lloyd, MS, Kenia del los Santos and Suzanne Daly (co-managers), the BSCO teaches students, primarily ophthalmology residents, from all over the world. The four-week course consists of approximately 120 hours of lectures on clinical ophthalmology and vision research plus 25 hours of workshops and wet-labs, with lecturers from Columbia University as well as national and international luminaries in their fields.

Staff Harriet O. Lloyd, MS, Senior Staff Associate Raksha Urs, PhD, Associate Research Scientist

This provider does not accept new patients

Research Interests

Imaging and characterization of ocular tissues with ultrasound alone or in combination with optics

The use of high-resolution ultrasound to map the layers of the cornea to detect changes indicative of early keratoconus

The use of ultrasound to remotely palpate tissues such as the cornea or retina to non-invasively probe their elastic properties, using both ultrasound and optical coherence tomography to measure ultrasound-induced tissue displacements

The use of lasers in combination with ultrasound in a process called photoacoustic imaging to visualize light-absorbing tissue structures, such as the microvasculature

Ultrasound-enhanced drug delivery and advanced probe design and signal processing for improved sensitivity and resolution in ultrasound images

NIH Grants

OCULAR HEMODYNAMICS OF RAT MODEL OF GLAUCOMA (Federal Gov)

May 1 2018 - Apr 30 2022

BASIC SCIENCE COURSE IN OPHTHALMOLOGY (ALCON) (Private)

Jan 8 2018 - Feb 2 2018

BASIC SCIENCE COURSE IN OPHTHALMOLOGY (CZMI) (Private)

Jan 8 2018 - Feb 2 2018

BASIC SCIENCE COURSE IN OPHTHALMOLOGY (NOVARTIS) (Private)

Jan 8 2018 - Feb 2 2018

ELASTOGRAPHIC IMAGING OF THE RETINA/CHOROID IN AGE-RELATED MACULAR DEGENERATION (Federal Gov)

Feb 1 2012 - Jan 31 2017

BASIC SCIENCE COURSE IN OPHTHALMOLOGY (Private)

Jan 2 2017 - Jan 27 2017

QUANTITATIVE CHARACTERIZATION OF VITREOUS IN VITREOUS DEGENERATION IN MYOPIA (Federal Gov)

Jan 1 2015 - Dec 31 2016

AN ALL-OPTICAL PHOTACOUSTIC IMAGING SYSTEM FOR THE EYE (Federal Gov)

Sep 30 2014 - Aug 31 2016

BASIC SCIENCE COURSE IN OPHTHALMOLOGY (Private)

Jan 4 2016 - Jan 29 2016

HOLOGRAPHY-BASED PHOTOACOUSTIC IMAGING OF THE RETINA (Federal Gov)

Sep 1 2013 - Aug 31 2015

EARLY DETECTION OF KERATOCONUS (Federal Gov)

Sep 30 2009 - Aug 31 2015

BASIC SCIENCE COURSE IN OPHTHALMOLOGY (Private)

Jan 3 2013 - Mar 31 2013

ACOUSTIC CONTRAST AGENTS FOR USE WITH HIGH-FREQUENCY ULTRASO UND (Federal Gov)

Sep 1 2011 - Aug 31 2012

NON INVASIVE 3-D IMAGING OF TISSUE CULTURE (Federal Gov)

Jan 5 2012 - Jun 15 2012

HIGH-FREQUENCY-ULTRASOUND ANNULAR ARRAYS FOR OPHTHALMIC AND SMALL-ANIMAL IMAGING (Federal Gov)

Apr 1 2010 - Mar 31 2012

HIGH RESOLUTION PHOTOACOUSTIC IMAGING OF OCULAR AND SUPERFICIAL TISSUES HYDROLOGIC MODELS (Federal Gov)

Sep 21 2010 - Sep 21 2011

ACOUSTIC CONTRAST AGENTS FOR USE WITH HIGH-FREQUENCY ULTRASO UND (Federal Gov)

May 1 2010 - Aug 31 2011

Publications

Rohrbach D, Ito K, Lloyd HO, Silverman RH, Yoshida K, Yamaguchi T, Mamou J. Material properties of human ocular tissue at 7-µm resolution. Ultrasonic Imaging 2017;39(5):313-325

Silverman RH, Urs R, RoyChoudhury A, Archer TJ, Gobbe M, Reinstein DZ. Computer-assisted diagnosis of keratoconus by combined Pentacam and Artemis. Eur J Ophthalmol 2017; 27(2):129-134

Rohrbach D, Jakob A, Lloyd HO, Tretbar SH, Silverman RH, Mamou J. A novel 500-MHz acoustic-microscopy system for ophthalmologic tissues. IEEE Trans Biomed Eng. 2017;64(3):715-724.

Reinstein DZ, Archer TJ, Gobbe M, Urs R, Silverman RH. Diagnosing Keratoconus Using VHF Digital Ultrasound Epithelial Thickness Profiles. In: Keratoconus. Recent Advances in Diagnosis and Treatment. Jorge L. Alió, ed. Springer 2017, pp 151-166.

Ketterling JA, Silverman RH. Clinical and preclinical applications of high-frequency ultrasound. Acoustics Today. Volume 13, Spring 2017.

Silverman RH. Focused ultrasound in ophthalmology. Clinical Ophthalmology 2016;10:1865–1875. (Invited paper)

Urs R, Ketterling JA, Silverman RH. Ultrafast ultrasound imaging of ocular anatomy and blood flow. Invest Ophthalmol Vis Sci. 2016:57(8):3810-6.

Urs R, Lloyd HO, Reinstein DZ, Silverman RH. Comparison of very high-frequency ultrasound and spectral domain optical coherence tomography corneal and epithelial thickness maps. J Cat Refract Surg. 2016;42(1):95-101.

Reinstein DZ, Archer TJ, Urs R, Gobbe M, RoyChoudhury A, Silverman RH. Detection of keratoconus in the clinically and algorithmically topographically normal fellow-eyes of unilateral keratoconus using epithelial thickness analysis. J Refract Surg. 2015 1;31(11):736-44.

Reinstein DZ, Yap TE, Archer TJ, Gobbe M, Silverman RH. Comparison of corneal epithelial thickness measurement between Fourier-domain optical coherence tomography and very high-frequency digital ultrasound. J Refract Surg. 2015;31(7):438-45.

Rohrbach D, Lloyd HO, Silverman RH, Mamou J. Fine-resolution maps of acoustic properties at 250 MHz of unstained fixed murine retinal layers. J Acoust Soc Am. 2015;137(5):EL381-387.

Mamou J, Wa CA, Yee KMP, Silverman RH, Ketterling JA, Sadun AA, Sebag J. Ultrasound-based quantification of vitreous floaters correlates with contrast sensitivity. Invest Ophthalmol Vis Sci. 2015;56:1611-1617.

Urs R, Lloyd HO, Silverman RH. Acoustic radiation force for the non-invasive evaluation of corneal biomechanical changes induced by cross-linking therapy. J Ultrasound Med. 2014;33(8):1417-26.

Silverman RH, Urs R, RoyChoudhury A, Archer T, Gobbe M, Reinstein DZ. Epithelial remodeling as basis for machine-based identification of keratoconus. Invest Ophthalmol Vis Sci. 2014:55(3):1580-7.

Sebag J, Silverman RH, Coleman DJ. To See the Invisible - the Quest of Imaging Vitreous. In: Vitreous in Health and Disease, J. Sebag, ed. Springer, 2014.

Silverman RH, Urs R, Lloyd HO. Effect of ultrasound radiation force on the choroid. Invest Ophthalmol Vis Sci. 2013;54(1):103.

Ursea R, Feng M, Urs R, RoyChoudhury A, Silverman RH. Comparison of Artemis-2 ultrasound and Visante optical coherence tomography corneal thickness profiles. J Refract Surg. 2013;29(1):36-43.

Lethiecq M, Lou–Moeller R, Ketterling JA, Levassort F, Tran-Huu-Hue LP, Filoux E, Silverman RH, Woln WW. Non-planar pad-printed thick-film focused high-frequency ultrasonic transducers for imaging and HIFU applications. IEEE Trans Ultra Ferro Freq Contr. 2012;59(9):1976-82.

Silverman RH, Ketterling JA, Mamou J, Lloyd HO, Filoux E, Coleman DJ. Pulse-encoded ultrasound imaging of the vitreous with an annular array. Ophth Surg Lasers Imag. 2012;43(1):82-6.

Kong F, Silverman RH, Liu L, Chitnis P, Chen YC. Photoacoustic-guided convergence of light through optically diffusive media. Optics Letters. 2011;36(11):2053-2055.

Kim, D. Y., Silverman, R. H., Chan, R. V. P., Khanifar, A. A., Rondeau, M., Lloyd, H., Schlegel, P. and Coleman, D. J. Measurement of choroidal perfusion and thickness following systemic sildenafil (Viagra®). Acta Ophthalmologica, 2013;91: 183–188.

Reinstein DZ, Gobbe M, Archer TJ, Silverman RH, Coleman DJ. Epithelial, stromal, and total corneal thickness in keratoconus: three-dimensional display with Artemis very-high frequency digital ultrasound. J Refract Surg. 2010;26(4):259-71.

Silverman RH, Kong F, Chen YC, Lloyd HO, Kim HH, Cannata JM, Shung KK, Coleman DJ. High-resolution photoacoustic imaging of ocular tissues. Ultra Med Biol 2010;36:733-742.

Ursea R, Silverman RH. Anterior segment imaging for assessment of glaucoma. Exp Rev Ophthalmol. 2010:5;59-74.

Mamou J, Aristizabal O, Silverman RH, Ketterling JA, Turnbull DH. High-frequency chirp ultrasound imaging with an annular-array for ophthalmologic and small-animal imaging. Ultra Med Biol. 2009;35:1198-1208.

Silverman RH, Patel MS, Gal O, Sarup A, Deobhakta A, Dababneh H, Reinstein DZ, Feleppa EJ, Coleman DJ. Effect of corneal hydration on ultrasound velocity and backscatter. Ultra Med Biol. 2009;35:839-846.

Silverman RH. High-resolution ultrasound imaging of the eye. Clin Exp Ophthalmol. 2009;37(1):54-67.

Kong F, Chen Y-C, Lloyd HO, Silverman RH, Kim H, Cannata JM, Shung KK. High-resolution photoacoustic imaging with focused laser and ultrasonic beams. Appl Phys Lett. 2009; 94, 033902-1-3.

Kim HH, Cannata J, Liu R, Chang JH, Silverman R, Shung K. 20 MHz/40 MHz dual element transducers for high frequency harmonic imaging. IEEE Trans Ultra Ferro Freq Contr. 2008;55:2683-2691.

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Silverman RH, Ketterling JA, Mamou J, Coleman DJ. Improved high-resolution ultrasonic imaging of the eye. Arch Ophthalmol. 2008;126:94-97.

Silverman RH, Ketterling JA, Coleman DJ. High-frequency ultrasonic imaging of the anterior segment using an annular array transducer. Ophthalmology. 2007;114:816-822.