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Light for Life: International Year of Light 2015

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This special section is dedicated to the International Year of Light 2015, as announced by UNESCO. It runs in parallel with a session under the same theme of "Light for Life" at the European Conference of Biomedical Optics as part of the World of Photonics Congress held in Munich, Germany 21-25 June 2015. International experts are invited to share their vision of where research is headed in the different fields, what might be a promising future direction, and how those developments will help to improve our life and health in general.

Light technologies revolutionized the medical field by improving both diagnostics and treatment. This special section should give a small cross-sectional view across biophotonics, highlighting various developments in this exciting field. Our armory to fight life-threatening diseases has been significantly enhanced by light-based technologies, either by improved diagnostics, or by providing efficient image guidance during surgery, or for treatment itself.

One important approach is photodynamic therapy, where photosensitive drugs help to specifically target and destroy malignant cells. This technique has been gradually improved both from the technical side as well as from the biochemical side, and photodynamic therapy is nowadays an effective treatment option for various tumors.

Still, many other promising laser applications that have been successfully demonstrated in a research environment are still far from being used in clinical practice due to the cumbersome, expensive, and time-consuming pathway to their actual translation.

Biomedical imaging techniques, on the other hand, are widely used both in research as well as in clinical routine. Microscopy techniques, for example, have experienced a boost in imaging speed, penetration depth, and resolution performance. We live in exciting times, as three Nobel prizes were awarded in 2014 for opening the door to optical in-vivo nanometer imaging.

Nonlinear microscopy shows how to improve depth penetration into scattering tissue, maintaining molecular specificity,

and gives revolutionizing insights into the living brain. Those developments are efficiently supported by developments in sensor and light-source technology that help to improve detection sensitivity, speed performance, and temporal resolution. Fluorescence lifetime as well as Raman sensitive imaging that gained from those developments give insight into tissue metabolism and are sensitive biomarkers of early tissue alterations.

Recently introduced temporal focusing techniques created large interest, as they allow parallel acquisition of multiphoton signatures over the full focal plane, thereby speeding up volumetric tissue imaging.

An imaging technique that has found rapid uptake in medical diagnostics is optical coherence tomography, with the only drawback of missing molecular specificity. The latter can be provided by photoacoustic imaging together with better tissue penetration depth, which is a hybrid technology combining optical with ultrasound imaging.^{1,2} In fact, most promising is a multimodal approach, bringing together the strengths of complementary imaging techniques.

Correlative microscopy aims in the same direction, correlating information from different imaging technologies that range from magnetic resonance to light and electron microscopy, and thereby bridging the gap between temporal and spatial scales of brain function.

We believe that this special section is a valuable source of information for interested readers even outside of the biomedical optics community. They might get a glimpse of how light technologies impact biology and medicine today, how they reshaped our understanding in biomedical research, and what can be expected from developments of tomorrow's technologies.

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Rainer A. Leitgeb received his PhD in theoretical physics from the Technical University Vienna. Since 2004, he has been an associate professor at the Medical University of Vienna specializing in functional OCT, multimodal imaging, and advanced microscopy. Since 2015 he has been head of the Christian Doppler Laboratory for Innovative Optical Imaging and its Translation to Medicine. From 2004 to 2007 he worked at the EPFL, Switzerland, as an invited professor. He has authored 9 patents, and has published more than 150 research papers. He has been awarded the ARVO/ALCON early career clinical scientist award and is an SPIE Fellow.

Peter E. Andersen (PhD 1994) is with DTU Fotonik, Technical University of Denmark, where he leads in two areas: lasers in biomedical applications, and multimodal biophotonic imaging. His main research interests are related to studies of light propagation in biological tissues in relation to optical coherence tomography, development and applications of diode-based laser systems for biophotonics, and biophotonic multimodal imaging. He has published more than 150 journal/conference papers within these topics, and holds eight patents. He is deputy editor of *Optics Letters*, an editorial board member of the *Journal of Biomedical Optics*, an associate editor of the *Journal of Biophotonics*, and the co-founder and co-inventor of Norlase ApS, Denmark. He is an SPIE Fellow and an OSA Fellow.

Jürgen Popp studied chemistry at the universities of Erlangen and Würzburg, Germany. Since 2002, he holds a chair for physical chemistry at the Friedrich-Schiller University Jena. Furthermore, he is the scientific director of the Leibniz Institute of Photonic Technology, Jena, since 2006. His research interests are mainly concerned with biophotonics. He has published more than 540 journal papers and has been named as an inventor on 12 patents in the field of spectroscopic instrumentation.

Nimmi Ramanujam is a professor of biomedical engineering at Duke University. She leads a multidisciplinary translational research program focused on the development of novel optical technologies for noninvasive or minimally invasive assessment of breast and cervical cancer. In October 2013, Nimmi founded the Global Women's Health Technologies Center, a partnership between the Pratt School of Engineering and the Duke Global Health Institute. Nimmi earned her PhD in biomedical engineering from the University of Texas, Austin, in 1995 and then trained as an NIH postdoctoral fellow at the University of Pennsylvania from 1996–2000. Prior to her tenure at Duke, she was an assistant professor in the Department of Biomedical Engineering at the University of Wisconsin, Madison, from 2000–2005.

Katarina Swanberg (MD, PhD) holds a professorship in oncology at Lund University, Sweden, as well as at South China Normal University, Canton, China. She started her research by studying laser light interaction in biological tissue and has combined her clinical activity with research work. Following basic preclinical work in collaboration with the Lund Institute of Technology, she and colleagues introduced photodynamic therapy as a new cancer treatment modality in oncology at the Lund University Hospital. She has also been involved in developing a new method for gas monitoring: gas in scattering media absorption spectroscopy (GASMAS) in the human body. She has organized several conferences in biomedical optics for international societies and served as President of SPIE in 2011.