Abstract Summaries

SPIE Photonics West

Conferences: 24-29 January 2009
San Jose Convention Center • San Jose, California USA

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Conference 7180 · Room: Conv. Ctr. Room A4, Marriott Hotel, Willow Glen Room

Sunday-Monday 25-26 January 2009 • Proceedings of SPIE Vol. 7180

Photons and Neurons

Conference Chairs: **Anita Mahadevan-Jansen,** Vanderbilt Univ.; **E. Duco Jansen,** Vanderbilt Univ.

Program Committee: **Edward S. Boyden,** Massachusetts Institute of Technology; **Timothy J. Ebner,** Univ. of Minnesota; **Maarten Frens,** Erasmus Univ. Medical Ctr. (Netherlands); **Elizabeth M. C. Hillman,** Columbia Univ.; **Henry Hirschberg,** Univ. of California, Irvine; **Steen J. Madsen,** Univ. of Nevada, Las Vegas; **Agnella Izzo Matic,** Northwestern Univ.; **Jonathon D. Wells,** Lockheed Martin Aculight

Sunday 25 January

SESSION JT1
Room: Conv. Ctr. Room A4, Marriott Hotel,
Willow Glen Room. . . . . Sun. 8:30 to 10:10 am

Joint Session on Neurobiology with Conference 7161E: Optical Techniques in Neurosurgery, Brain Imaging, and Neurobiology

Session Chair: **Steen J. Madsen,** Univ. of Nevada, Las Vegas

8:30 am: **Optical detection of action potential propagation using phase-sensitive interferometry**, Boris H. Park, Massachusetts General Hospital (United States); Christopher L. Passaglia, Boston Univ. (United States); Johannes F. de Boer, Massachusetts General Hospital (United States). . . . . .[7161E-520]

8:50 am: **Action potential detection by non linear microscopy**, Leonardo Sacconi, Jacopo Lotti, Univ. of Florence (Italy); Rodney P. O'Connor, Janelia Farm Research Campus (United States) and Univ. of Florence (Italy); Jonathan Mapelli, Daniela Gandolfi, Egidio D'Angelo, Univ. of Pavia (Italy); Francesco S. Pavone, Univ. of Florence (Italy) . . . . . .[7161E-521]

9:10 am: **Quantitative in vivo optical assessment of nerve myelination**, Boris H. Park, Frank P. Henry, Mark A. Randolph, Johannes F. de Boer, Massachusetts General Hospital (United States) . . . . . .[7161E-522]

9:30 am: **Neurobiological use of a micro-optrode using UV excitation light and signal-to-noise ratio optimization**, Suzie Dufour, Univ. Laval (Canada); Florin Amzica, Univ. de Montréal (Canada); Réal Vallée, Univ. Laval (Canada) . . . . . .[7161E-523]

9:50 am: **Reflected light imaging of ON and OFF responses in frog retina**, Xin-Cheng Yao, Chris Gorga, The Univ. of Alabama at Birmingham (United States) . . . . . .[7161E-524]

Coffee Break . . . . . .10:10 to 10:40 am

SESSION JT2
Room: Conv. Ctr. Room A4, Marriott Hotel,
Willow Glen Room. . . . . Sun. 10:40 am to 12:00 pm

Joint Session Neuroimaging II with Conference 7161E: Optical Techniques in Neurosurgery, Brain Imaging, and Neurobiology

Session Chair: **Henry Hirschberg,** Univ. of California, Irvine

10:40 am: **Investigation of the prefrontal cortex in response to duration-flexible anagram tasks using functional near infrared spectroscopy**, Fenghua Tian, The Univ. of Texas at Arlington (United States); Britton Chance, Univ. of Pennsylvania (United States); Hanli Liu, The Univ. of Texas at Arlington (United States). . . . . .[7161E-525]

11:00 am: **Noninvasive optical micro-angiography for structural and functional in vivo imaging of cerebro-vascular blood perfusion**, Yali Jia, Ruikang Wang, Oregon Health & Science Univ. (United States). . . . .[7161E-526]

11:20 am: **Characterization of the newborn visual activation response using high density diffuse optical imaging (HD-DOI)**, Steve M. Liao, Nicholas M. Gregg, Brian R. White, Terrie E. Inder, Joseph P. Culver, Washington Univ. in St. Louis School of Medicine (United States) . . . . . .[7161E-527]

11:40 am: **A simultaneous NIRS&EEG study during seizure in the mouse brain**, Seungduk Lee, Dalkwon Koh, Beop-Min Kim, Yonsei Univ. (Korea, Republic of); Mina Lee, Jee Hyun Choi, Korea Institute of Science and Technology (Korea, Republic of) . . . . . .[7161E-528]

Lunch/Exhibition Break . . . . . .12:00 to 1:30 pm

SESSION 1
Room: Conv. Ctr. Room A4, Marriott Hotel,
Willow Glen Room. . . . . Sun. 1:30 to 3:10 pm

Joint Session on Detecting Neural Activity I with Conference 7161E: Optical Techniques in Neurosurgery, Brain Imaging, and Neurobiology

Session Chair: **E. Duco Jansen,** Vanderbilt Univ.

1:30 pm: **Theoretical study on the origin of fast intrinsic optical responses**, Jonghwan Lee, Sung June Kim, Seoul National Univ. (Korea, Republic of). . . . . .[7180-01]

1:50 pm: **Mitochondrial function and cerebral blood flow responses under unilateral carotid occlusion in rats**, Amir Livnat, Efrat Barbiro-Michaely, Avraham Mayevsky, Bar-Ilan Univ. (Israel) . . . . . .[7180-02]

2:10 pm: **Relation between the neuronal and hemodynamic response in the rat spinal cord following peripheral nerve stimulation**, Dubeau Simon, Frédéric Lesage, Ecole Polytechnique de Montréal (Canada); Éric Beaumont, Hopital Sacre Coeur de Montreal (Canada) . . . . . .[7180-03]

2:30 pm: **Translation of near infrared brain imaging to assess children with cerebral palsy**, George Alexandrakis, Khosrow Behbehani, Nayan Asanani, Bilal Khan, Fenghua Tian, The Univ. of Texas at Arlington (United States); Mauricio Delgado M.D., Texas Scottish Rite Hospital for Children (United States); Hanli Liu, The Univ. of Texas at Arlington (United States) . . . . . .[7180-04]

2:50 pm: **Limits to non-fluorescent voltage sensitivity using surface and particle plasmons**, Mark C. Pitter, John D. Paul, Jing Zhang, Mike G. Somekh, The Univ. of Nottingham (United Kingdom) . . . . . .[7180-05]

Coffee Break . . . . . .3:10 to 3:30 pm

SESSION 2
Room: Conv. Ctr. Room A4, Marriott Hotel,
Willow Glen Room. . . . . Sun. 3:30 to 5:30 pm

Joint Session on Detecting Neural Activity II with Conference 7161E: Optical Techniques in Neurosurgery, Brain Imaging, and Neurobiology

Session Chair: **Edward S. Boyden,** Massachusetts Institute of Technology

3:30 pm: **Of mice, men, and microscopes: watching cellular level dynamics in behaving subjects**, Mark J. Schnitzer, Stanford Univ. School of Medicine (United States). . . . . .[7180-29]

3:50 pm: **Depth-encoded spectral domain phase microscopy for simultaneous multi-site nanoscale optical measurements of nerve activation**, Bradley A. Bower, Duke Univ. (United States); Neal Shepherd, Duke Univ. Medical Ctr. (United States); Alex S. Reinstein, Yuankai K. Tao, Joseph A. Izatt, Duke Univ. (United States) . . . . . .[7180-06]

4:10 pm: **Depth localization of neural action potentials using voltage sensitive dyes in optical coherence tomography**, Taner Akkin, Univ. of Minnesota (United States); David Landowne, Univ. of Miami (United States); Aarthi Sivaprakasam, Univ. of Minnesota (United States). . . . . .[7180-07]

4:30 pm: **Optical probing of photoreceptor function: theoretical model and experimental verification in an in-vivo rat model**, Kostadinka K. Bizheva, Zhao Ren, Univ. of Waterloo (Canada); Aphrodite Dracopoulos, St. Michael's Hospital (Canada); Alireza Akhlagh Moayed, Sepideh Hariri, Univ. of Waterloo (Canada); Timothy W. Kraft, The Univ. of Alabama at Birmingham (United States); Bruce Doran, Diagnosys, LLC (United States); Shelley Boyd, St. Michael's Hospital (Canada) . . . . . .[7180-08]

Theoretical study on the origin of fast intrinsic optical responses

Jonghwan Lee and Sung June Kim

100-word abstracts for early printed program:

Recently, several studies including ours have reported fast intrinsic optical responses from various neural preparations. Although these studies measured different optical properties, their result commonly showed the monophasic change and larger relaxation time constant than that of the electrical signal. To elucidate this difference in quantitative way, this study developed a new neuron model with variable cellular volume and intracellular ion concentration, which were constant quantities in the Hodgkin-Huxley model. As the result, the action potential induced cellular volume changes with the time course and fractional variation similar to those of measured optical responses.

250-word abstracts for review:

There has been recently growing interest in optical recording of neural activity. Several studies including ours have reported fast intrinsic optical responses from various neural preparations. Although these studies measured different optical properties such as the transmittance, scattering and birefringence, their results illustrated a couple of common features in the optical signals. The optical responses show the monophasic change with larger relaxation time constant rather than that of the electrical signal. This implies that the optical responses might represent other neurophysiological event than the neuronal membrane potential. Some previous studies have tried to elucidate qualitatively the origin of the optical responses using the cellular swelling. However, no study, to our knowledge, has verified this hypothesis in quantitative way. In this study, the cellular volume change associated with neural activity was theoretically calculated and compared with the measured optical signals. For this calculation, we developed a new neuron model with variable cellular volume and intracellular ion concentration, which were constant quantities in the Hodgkin-Huxley model. Using physical theories such as the Nernst-Planck equation of diffusion and the continuity equation of conservation, we built a set of coupled nonlinear differential equations to connect variables in our

model. As the result of numerical computation, the cellular volume showed the monophasic change, the time course of which was similar to that of the optical response. In addition, the amount of fractional changes in the cellular volume also approximately agrees with that of the optical response in the order of magnitude.

Keywords (up to 8 words or phrases):

Intrinsic optical signal

Neuron model

Quantitative cellular swelling

Brief biography of the first author (50 to 100 words):

Jonghwan Lee

Academics:

2000, Bachelor of Science, Department of Physics, Seoul National University, Korea

2004-now, PhD Track, Brain Science, Seoul National Univeristy, Korea

Work:

2000-2003, Software Programmer, Korean Military Service

2008-now, Research Assistant, Nano Bioelectronics and Systems Research Center, Korea

Career Interest:

Fast intrinsic optical neural recording and its application to brain-computer interface