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Presentation Abstract

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Presentation Title:	Modeling the light propagation in brain tissues using Monte Carlo simulation with a dynamic and heterogeneous tissue model
Location:	WCC Hall A-C
Presentation time:	Sunday, Nov 16, 2014, 9:00 AM -10:00 AM
Presenter at Poster:	Sun, Nov. 16, 2014, 10:00 AM - 11:00 AM
Topic:	++G.03.a. Staining, tracing, and imaging techniques
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Abstract:	The advent of two-photon fluorescence microscopy has opened unprecedented opportunities in revealing neuronal firing, hemodynamic changes, and metabolic activity on microscopic level in vivo. However, data interpretation of two-photon fluorescence microscopy on dyes with small signal change such as β-nicotinamide adenine dinucleotide (NADH), a key metabolic marker, faces enormous challenge because the measured signal change is often highly distorted by hemodynamic changes. Prior work by Baraghis et al modeled two-photon NADH fluorescence with precise maps of cortical microvasculature [Baraghis et al, Journal of Biomedical Optics 16, 106003 (2011)] and corrected for the measured NADH signal change by using the fluorescence change of Sulforhodamine 101 (SR101), a functionally inert dye topically applied to the cortex. The correction scheme works adequately when the goal is to maintain the correct sign of the signal change. However, it was not performed for a realistic three dimensional (3D) microvasculature, but rather using a single value found empirically. Here, we extend the prior work to calculate the point to point correction factor using a 3D microvasculature. More specifically, we consider the two-photon fluorescence as a two-step process: two-photon excitation (light propagates from surface to focal point) and fluorescence detection (light propagates

from focal point back to surface). We use ray tracing scheme in both processes and consider the effects of light scattering and absorption due to blood vessels. We will present the correction factors and apply these factors to extract the real NADH signal changes measured using rodent model. We will also compare this correction scheme with the simple one-value approach. Our study may help quantify cellular NADH signal change and is also applicable to two-photon fluorescent measurements where changes of tissue optical properties affect measured signals, thus allowing more accurate interpretation of functional imaging studies.

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