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EFFECT OF MULTIPLE SCATTERING ON MEASURED SIGNAL LOSSES USING OPTICAL COHERENCE TOMOGRAPHY STUDIED BY MONTE CARLO SIMULATION

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Abstract. *The noninvasive glucose measurement with optical coherence tomography (OCT) relies on the glucose induced change of OCT signal slope. The Monte Carlo simulation is performed to study the effect of multiple scattering on the measured signal losses. The OCT signal is divided into two categories: one is from the target layer in the medium (LSP); the other is from the rest of the medium (MSP). The results show the MSP signal decays much more slowly than the LSP signal. The LSP contribute to the precise OCT signal and the MSP degrades the OCT signal. Signal decays constantly and the decay constant increases with the increasing scattering coefficient. Experiment results are also presented to show how multiple scattering affects the measured OCT signal losses.*

Keywords: Optical coherence tomography, Monte Carlo simulation, Noninvasive glucose measurement, Multiple scattering

1. **Introduction.** Currently, optical coherence tomography (OCT) imaging of highly scattering biological tissues is attracting a great deal of interest, because its capability to delineate non-invasively sub-surface microstructures has the potential to improve the diagnostic limits of currently available imaging techniques, allowing a wide range of clinical disorders to be addressed at an early stage [1, 2, 3]. OCT relies on the penetration and back-scattering of light into tissue to construct cross-sectional tomographic images. It actually collects the back-scattered photons that have experienced less scattering, i.e. ballistic or least-scattered photons. However, unlike the transparent ocular organs where OCT found its most successful applications [4], there is no evidence that an OCT imaging depth beyond 2 mm for opaque biological tissues is possible [5, 6]. This is largely due to the multiple scattering inherent in the interactions between the probing light and the targeted tissue, which limits light penetration into the tissue, and therefore prevents the deep micro-structures from imaging. Generally, multiple scattering could degrade signal attenuation and localization, leading to an image artefact that reduces the imaging depth, degrades the signal localization and affects the image contrast.

Mathematical models have been developed to better interpret and understand the OCT signals from a highly scattering medium, thereby enabling the development of optimized OCT instrumentation and data processing algorithms. The single scattering model describes the OCT imaging processes as the probing light into the tissue being continuously attenuated according to the total extinction coefficient of the propagation medium [7]. It was then quickly realized that this model appears to give an incomplete description of beam propagation progressing deep into the tissues where the multiple scattering effect