Q 59: Poster: Symposium Biomedical Optics (SYBO)

Time: Thursday 16:30–19:00 Location: Empore Lichthof

Q 59.1 Thu 16:30 Empore Lichthof

Determination of absorption and effective scattering in three-layered biological tissue using the diffusion and P_3 approximation — •Simeon Müller, Dominik Reitzle, André Liemert, and Alwin Kienle — Institut für Lasertechnologien in der Medizin und Meßtechnik, Helmholtzstr. 12, 89081 Ulm, Germany

Clinically relevant parameters can be deduced from the scattering and absorption properties of tissue. The radiative transfer equation (RTE) describes light propagation in biological tissue. Solutions are obtained applying different approximations. The most widely used one is the diffusion approximation. It has been solved for infinite, half space and layered geometries but has limitations for short times and small source-detector separations. The spherical harmonic (P_n) approximation approaches the exact solution to the RTE for high orders n. It has recently been solved by our group for the above mentioned geometries.

One way to determine the optical properties of scattering media are time domain measurements. A short pulsed laser beam is targeted on the medium and the time resolved reflectance signal from the surface is measured at a certain distance. Determination of the optical properties is then accomplished by fitting the mentioned models to the measured signal.

With simulated time domain measurements, the determination of the optical properties in three-layered media is investigated, comparing the different approximations. It is shown that already P_3 offers a significant improvement to the diffusion theory for optical properties in the typical range of biological tissue.

Q 59.2 Thu 16:30 Empore Lichthof

Separation of absorption and reduced scattering by multispectral Spatial Frequency Domain Imaging utilizing analytical solutions of the RTE — •Steffen Nothelfer, Dominik Reitzle, Florian Foschum, Philipp Krauter, André Liemert, and Alwin Kienle — Institut für Lasertechnologien in der Medizin und Meßtechnik, Helmholtzstr. 12, D-89081 Ulm, Germany

Extensive investigations on Spatial Frequency Domain Imaging (SFDI) are done for separation of absorption (μ_a) and reduced scattering coefficient (μ_s'). However, for an accurate and absolute determination of e.g. drug concentrations, spectrally resolved measurements are generally inevitable. Moreover, structural and morphological changes of tissue or other substances mostly result in a change of the reduced scattering spectra. A new contact free and rapid method for measuring absorption and the reduced scattering coefficient spectra from 500 nm to 1000 nm is presented. Therefore a push broom spectral imager (InnoSpec, Germany) is used to map each point of a line parallel to a sinusoidal spatial intensity modulation spectrally resolved onto a CCD sensor. These images are post-processed with a special FFT algorithm to obtain the spectral resolved reflectance in the spatial frequency domain. To solve the inverse problem of separating absorption and reduced scattering, a nonlinear least squares regression is used, which applies analytical solutions of the Radiative Transfer Equation (RTE).

Q 59.3 Thu 16:30 Empore Lichthof

Angular resolved light scattering microscopy on human chromosomes — •Dennis Müller, Julian Stark, and Alwin Kienle — Institute for Lasertechnologies in Medicine and Metrology at Ulm University

Common optical methods to karyotype human chromosomes rely on marker substances. Scattering light microscopy promises to be a method to distinguish human chromosomes marker-free, when supported with suitable theoretical models.

The scattering light microscope setup consists of an inverse microscope with an AOTF - supercontinuum laser combination as source, providing collimated broadband light and monochromatic light with a tuneable wavelength at high intensities. The backscattered light can be sampled with a spectrometer or angular resolved via a CCD camera, positioned in the Fourier plane [1].

With this setup, the angular resolved scattering pattern of human chromosomes were measured. The measurement conditions were modelled using the Amsterdam Discrete Dipole Approximation (ADDA), an open source light scattering simulation software based on Maxwell's equations. Measurement and simulation results show a high correlation with a strong sensibility to the chromosome's geometrical properties. Hence, this method promises to become a powerful, marker-free tool in measuring geometrical features of organic samples well below the resolution limit of common light microscopy.

[1] M. Schmitz, T. Rothe, A. Kienle, Biomed. Opt. Express, Vol.2, No. 9, p.2665-2678 (2011)

Q 59.4 Thu 16:30 Empore Lichthof

Separation of the reduced scattering and absorption coefficients of layered media using an enhanced integrating sphere setup — •Florian Bergmann, Florian Foschum, and Alwin Kienle — Institut für Lasertechnologien in der Medizin und Meßtechnik, Ulm, Deutschland

The integrating sphere is a well-known "golden standard method" to estimate optical properties of biological tissue. In contrast to other standard methods like spatially resolved-, time resolved- or temporal frequency resolved reflectance the integrating sphere setup allows the study of samples having small volumes.

Our enhanced integrating sphere setup using a layered GPU Monte Carlo simulation of light propagation for evaluation enables the separation of the reduced scattering μ_s' and absorption μ_a coefficients in a spectral range of 400 to 1700 nm. Validation of the setup was done by preparation of epoxy resin phantom slabs with well-known optical properties in a range of $0.5\,\mathrm{mm}^{-1} < \mu_s' < 30\,\mathrm{mm}^{-1}$ and $10^{-3}\,\mathrm{mm}^{-1} < \mu_a < 10\,\mathrm{mm}^{-1}$. The results were compared with semi-infinite phantoms having the same properties as the slabs using other standard methods.

The next step is to separate the reduced scattering and absorption coefficients of layered biological samples like tissue.