

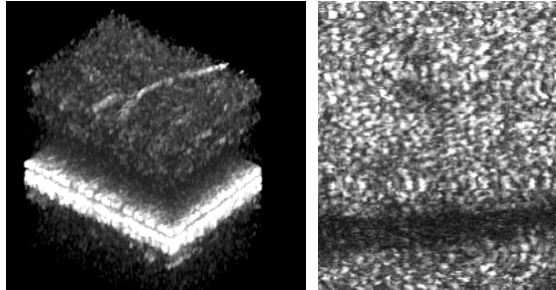
# ULTRA-HIGH SPEED OPTICAL COHERENCE MICROSCOPY

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Spectral optical coherence microscopy (SOCM) [1] combines the advantages of spectral OCT such as imaging speed, detection sensitivity and the availability of signal phase with the high lateral resolution of microscopy. Recently introduced extended focus SOCM allows for constant



transverse resolution along an extended depth range. This paves the way to non-invasive and label free microscopic in-vivo imaging. The unique advantage of SOCM however is the ability to directly access sample phase information. Typical micro-circulation flow velocity values are of the order of mm/sec or nm/ $\mu$ s. Hence after a recording time of 10 $\mu$ s blood traveled small distance of 10nm! Such distance can only be resolved by an

interferometric measurement modality such as Doppler SOCM. In spectral OCM inverse Fourier transform of the spectral interference pattern gives access to signal amplitude as well to phase as a function of depth. Doppler SOCM displays the differential phase between successive recordings that is directly proportional to the axial speed of structure at motion. This offers a highly sensitive and quantitative parameter to assess tissue perfusion.

We developed Doppler processing schemes that extract full volumetric tissue micro-circulation plots from 3D data recorded in only a few seconds. From such images one can determine vascularization density which is of high interest for diagnosis as well as for tumor staging. In a new generation system we implemented novel CMOS detector technology which boosts achievable imaging speeds up to 300.000 depth profiles per second [2]. This dramatically reduces measurement time and thus motion artifacts for in-vivo applications. Microscopic details such as individual photoreceptors of the retina can now be revealed in-vivo (Fig. rhs). Even more, we acquired volume time series of micro-vascular flow within the retina at a rate of 13 volumes per second with 150 x 200 x 800 pixels per volume (Fig. lhs, 300x300x800 $\mu$ m).

Such novel functional imaging capabilities will have an important impact for evaluating tissue health and physiology on microscopy level in-situ.

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[2] T. Schmoll, Ch. Kolbitsch, R.A. Leitgeb, “Ultra-high speed volumetric tomography of human retinal blood flow”, submitted to *Opt. Express* (2009).