High-Throughput Volumetric OCM

We utilized hyAO to acquire volumetric datasets with astigmatism, in order to equalize the photon collection away from the nominal Gaussian beam focal plane. After post-data-acquisition CAO, we then have significantly greater depth range with good signal-to-noise ratio.

Fig. 4. Cross section of resolution phantom for throughput comparison. (a) OCT with standard Gaussian beam, (b) CAO-OCT with standard Gaussian beam, (c) OCT with astigmatic beam, (d) CAO-OCT with astigmatic beam, and (e) Gaussian focus scanning control fused from 18 volumes. Scale bars indicate 100 μm for all images.

CAO-OCM of Mouse Brain

* Collaboration with Schaffer-Nishimura group

We present volumetric OCM of mouse brain ex vivo with a large depth coverage and cellular resolution by combining focus scanning and CAO. We demonstrate reconstruction of a volume with lateral resolution of 2.2 μm, axial resolution of 3.7 μm and depth range of ∼12 mm in the scattering mouse brain, using only 11 OCT data sets acquired on a spectral-domain OCT system.

Fig. 9. Comparison of micro-structure observable with OCM and Two-photon microscopy (2PM). Vessels are indicated by arrows and cell bodies are indicated by circles. (a) Minimum intensity projection of OCM. (b) Maximum intensity projection of 2PM data. Scale bar represents 50 μm.

Summary

By splitting the ‘work’ of image formation in new ways between computational and hardware approaches, we have demonstrated new capabilities for volumetric OCM. This includes high-throughput imaging of 3D cell migration dynamics and microstructure of mouse brain. AD-OCT was shown to suppress the impact of speckle and MS. This ability to suppress MS provides a promising approach for future work on pushing the imaging depth limits of optical coherence microscopy.

References