Immuno-OCT: High resolution catheter based Structural and Molecular imaging in vivo

Johannes F. de Boer[a,b,*#,]

ᵃDepartment of Physics and Astronomy, VU Amsterdam, The Netherlands
ᵇLaserab Amsterdam, VU Amsterdam, The Netherlands
#corresponding author email: j.f.de.boer@vu.nl

Optical Coherence Tomography (OCT) provides high resolution (10-20 micron) cross sectional images of tissue in vivo up to a depth of 2-3 mm. OCT excels in imaging tissue morphology, and structural changes to tissue morphology, but lacks molecular sensitivity to signal protein or cell surface receptor (over) expression, needed to improve the sensitivity for tumor detection. PET/CT provides both structural (CT) and molecular sensitive (PET) information in vivo, and has become an important component of personalized medicine, both in tumor detection and evaluation of pharmacological treatment options by radiolabeling traced doses of pharmaceuticals. I will present the optical equivalent of PET/CT, Immuno-OCT, that has a 10-100 fold higher resolution, and is able to detect much smaller tumors at a much earlier stage. Immuno-OCT combines the structural imaging by OCT with Near Infrared Fluorescence (NIRF) imaging of fluorescently labelled monoclonal antibodies, to provide both structural information to a few millimeters in depth, and molecular contrast. To access relevant tissue, catheters and endoscopes are needed that can provide access to hollos organs like the esophagus, colon and lung. An integrated system and dual modality catheters as small as 1.4 mm diameter and pill size capsules will be presented.

Immuno-OCT can be used to image the epithelia of hollow organs, and in particular the esophagus, where the monitoring of Barrett's esophagus (a metaplastic replacement of squamous tissue into columnar tissue) is crucial to the early-stage detection of esophageal adenocarcinoma (EAC). A motorized capsule endoscope was fitted with a double clad fiber for dual-modality OCT-NIRF imaging of the esophagus. We present the first in vivo Immuno-OCT imaging of Barrett's esophagus patients after intravenous administration of fluorescently labeled Bevacizumab-800CW, a targeted monoclonal antibody labelled with IRDye800-CW, which binds to vascular endothelial growth factor. Resected samples from each patient were also imaged ex vivo using a galvanometer scanning system and full-field fluorescence scanning system

In addition, we will present Polarization sensitive OCT (PS-OCT), which provides unique contrast in tissue for birefringent structures such as collagen, nerves and muscle. Endoscopic PS-OCT results will be presented in the human lung in vivo to diagnose airway smooth muscle thickness in healthy and Asthma patients, and the presence of fibrosis in the distal lung for improved diagnosis of Interstitial Lung Disease.