Multimodal fibre-optic imaging probe for detection of atherosclerotic plaques using fluorescent nanoparticles

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Atherosclerosis is the build-up of plaques within blood vessel walls, which can occlude the vessels and cause strokes or heart attacks. Accurate *in vivo* identification of atherosclerotic plaques is difficult but is important for optimal treatment. Current imaging modalities either lack the required spatial resolution or fail to provide assessment of the biochemical composition of a plaque. Our team has developed a dual-modality intravascular imaging system, combining imaging modalities of optical coherence tomography (OCT) and fluorescence (Figure 1A). We have also developed a fibre-optic intravascular probe, with a miniaturised side-facing lens (125µm diameter) at the distal end to perform *in vivo* imaging. The probe utilises double-clad fibre to acquire the OCT signal through the fibre core and to detect fluorescence emission light through the fibre's inner cladding. To fluorescently-label the atherosclerotic plaques for detection, we utilise a porphysome nanoparticle which we show is accumulated in the plaque and is fluorescently excited at 660nm. We performed *in situ* imaging of atherosclerotic plaque in genetically modified mice fed with high cholesterol diet. Preliminary results show that fluorescence signal was detected in mice injected with porphysomes, while no fluorescence was detected in control mice. Co-registered OCT scans of the blood vessel, acquired with the same probe, indicated that porphysome fluorescence was measured at locations containing plaques, and verified with fluorescence microscopy (Figure 1B & 1C). This suggests that our multimodal intravascular probe has sufficient sensitivity to detect fluorescence from plaques labelled with porphysomes, and that the co-registered OCT scan providing high resolution structural images to aid in interpretation of the fluorescence.
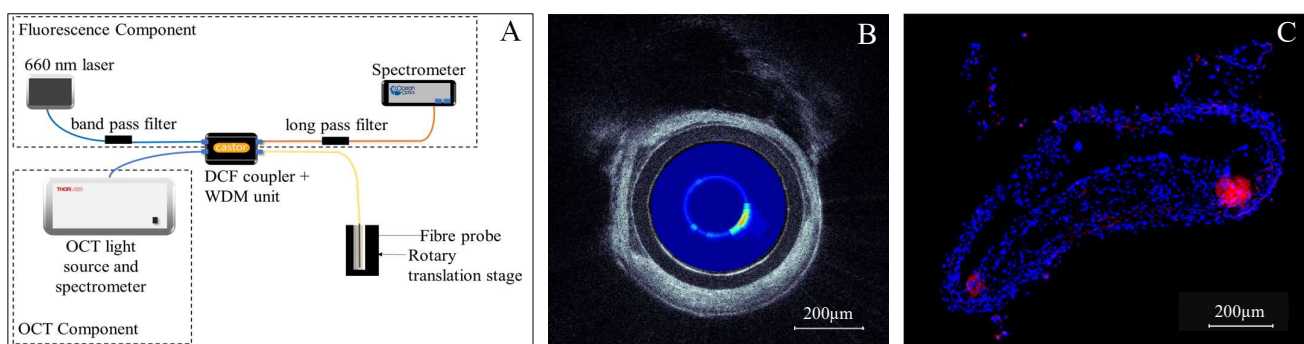

Figure 1: (A) Schematic of OCT + fluorescence system; colours of the line indicate the types of fibres used: blue: single mode fibre, orange: multimode fibre, yellow: double clad fibre; DCF: double clad fibre, WDM: wavelength division multiplexer (B)OCT (grey) and fluorescence image (colour) of mouse blood vessel marked with porphysomes nanoparticles, blue = lower fluorescence intensity, red = higher fluorescence intensity (C) corresponding fluorescence microscopy image– staining for cell nuclei (blue) and porphysome fluorescence (red)