# Multimodal imaging: Dedicated fiber optics combining coherent imaging with molecular sensitivity

Endoscopy has changed modern medicine by allowing physicians explore inner organs with minimal trauma. Single fiber endoscopes offer the potential to further increase patient comfort and increase access to remote organs through miniaturization. Current research focusses on sub-milimeter endoscopy using dedicated optical fibers for imaging large volumes of tissue. One such fiber - a double clad fiber - allows many imaging modalities to be performed simultaneously for greater diagnostic sensitivity and specificity. In this presentation, I will present our latest research in fiber optics for miniature endoscopy and discuss potential avenues, including *theragnostics*: the capability to treat a lesion as you discover it.

Double-clad fibers are increasingly used in biomedical imaging and multimodal sensing as they combine the benefits of single-mode (coherent illumination and detection) and multimode (massive incoherent detection) fibers. To improve mechanical stability and decrease the coupling losses of the current free-space beam-splitter approach, all-fiber DCF couplers (DCFCs) were developed. Previously reported DCFCs allow for quasi-lossless transmission of coherent single-mode signal (illumination and collection) and >40% transmission of multimodal signal (collection). These DCFCs have theoretical multimodal collection efficiency limited to 50%. In this presentation, I will describe double-clad fiber couplers capable of transmitting 90% of single mode core signal, while extracting >80% of the multimode signal from the inner cladding. These all-fiber couplers are robust, achromatic, quasi-lossless and insensitive to environmental conditions.

Biography:

Caroline Boudoux, PhD, obtained her PhD in 2007 from the Harvard-MIT Division of Health Sciences and Technology in biophotonics. She then studied coherent control applied to nonlinear microscopy at École Polytechnique (France) before joining the Engineering Physics department of École Polytechnique Montréal in 2007 as an assistant professor. She is now an associate professor and a faculty member of the Biomedical Engineering Institute. She is currently a Fulbright visiting scholar at Stanford University.

Her research focuses on biomedical optics, particularly the translation of optical diagnostics technologies for clinical applications in the fields of laryngology, head and neck surgery and orthopaedics. With her students and collaborators she develops wavelength swept lasers, optical fiber components and custom miniature lenses for confocal endomicroscopy, optical coherence tomography and fluorescent miniature endoscopy. Recently, she co-founded Castor Optics to commercialize a line of double-clad fiber couplers for biomedical sensing.