Brillouin microscopy for subcellular 3D mechanical imaging

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The mechanical properties of cells and tissues play a pivotal role in the pathophysiology of several diseases. Whilst standard elastography methods are either invasive or lack of subcellular resolution, Brillouin microscopy is a recently developed technique that has shown great potential to become a reliable diagnostic tool due to its capability of measuring viscoelastic properties of materials in a non-contact and non-invasive manner. In Brillouin microscopy, the spectrum of light is analyzed by a Virtually Imaged Phase Array (VIPA) spectrometer to retrieve the shift and width of the inelastic Brillouin peaks that are indicative of the stiffness properties of the material investigated.

In this tutorial, we describe the characterisation of a confocal Brillouin microscope designed to measure mechanical properties of biological systems. The frequency broadening of the Brillouin spectrum due to high illumination and collection apertures is investigated in order to determine the optimal geometry that maximises both the spectral and the optical resolution. Methods to enhance the spectral contrast of standard VIPA spectrometers are described. Moreover, sub-micron resolution Brillouin images of single cells and arterial wall tissues are here presented, promoting the application of Brillouin microscopy as a powerful tool for clinical applications.