Confocal Brillouin microscopy for micromechanical imaging

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1. INTRODUCTION Spontaneous Brillouin scattering is an inelastic process arising from the interaction of photons with thermal density fluctuations, or acoustic phonons, propagating in a medium. Over the last few years, Brillouin spectroscopy has shown great potential to become a reliable non-invasive diagnostic tool due to its unique optical capability of retrieving viscoelastic properties of materials such as strain and stiffness. The detection of the weak scattered light, in addition to the resolution of the Brillouin peaks (typically shifted by few GHz from the central peak) represent one of the greatest challenges in Brillouin spectroscopy. The recent development of high sensitivity CCD cameras has brought Brillouin spectroscopy from a point sampling technique to a new imaging modality. Furthermore, the application of Virtually Imaged Phased Array (VIPA) etalons has dramatically reduced insertion loss simultaneously allowing fast (<1s) collection of the entire spectrum. Hitherto, Brillouin microscopy has been shown the ability to provide unique stiffness maps of biological samples, such as the human lens, in a non-destructive manner [1]. The frequency broadening of the Brillouin spectrum due to finite illumination and collection apertures has been investigated in order to determine the optimal geometry that maximizes both the spectral and optical resolution. Experimental results confirm a narrower Brillouin peak in backscattering configuration enabling the employment of high NA microscope objectives [2].

2. DISCUSSION In this work, we describe the characterisation of a confocal Brillouin microscope designed to image the stiffness variations in the walls of blood vessels, in particular when atherosclerotic plaques are formed. The stiffness of the walls that cover the plaques are critical in developing acute myocardial infarction yet it is not currently possible to credibly assess their stiffness due to the low spatial resolution of standard methods. Brillouin images of both healthy (see figure above, Brillouin image on the left and a phase contrast image on the right hand side) and diseased mouse artery cross sections are presented. Preliminary results confirmed confocal Brillouin microscopy as a promising imaging method to enable an earlier diagnosis of coronary artery disease.

REFERENCES