Towards a compact multi-laser-beam device for cardiovascular screening.

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Introduction and Background

Non-contact laser vibrometer measurement of skin displacement is a technique that can lead to an improved screening and assessment of cardiovascular risk. The technique makes it possible to (a) measure aortic and local pulse wave velocity; (b) detect vibrations induced by turbulent blood flow in stenosed arteries; (c) pick up cardiac contraction abnormalities via measurements on the chest. [1,2,3]

Upon those foundations the objective of CARDIS (Early stage CARdio Vascular Disease Detection with Integrated Silicon Photonics *) is to investigate and demonstrate the concept of a mobile, low-cost device based on a multi-beam silicon photonics integrated laser vibrometer for easy targeting of a superficial artery and validate the concept for the screening of arterial stiffness, detection of stenosis and heart failure.

Preliminary Results

A 6-beam 1550nm Mach-Zehnder interferometer with integrated detectors has been designed and manufactured on single silicon Photonic Integrated Chip (PIC), using the iSiPP50G silicon photonics platform at Imec. Grating couplers are used for coupling light into and out from the interferometer, which also constitutes beam splitters and phase modulators. A 1550nm semiconductor laser with beam shaping optics and a miniature optical isolator is mounted directly onto the PIC for consistent coupling of laser beam into the interferometer as well as for miniaturization and robustness.

A range of optical systems for beam control and focusing each of the laser beams onto the skin has been evaluated and proven to work. Electronics have been developed for signal conditioning and instrument control. Initial measurements show the laser vibrometer is capable of measuring displacement of a moving target with sub um resolution, beyond the needs of the application.

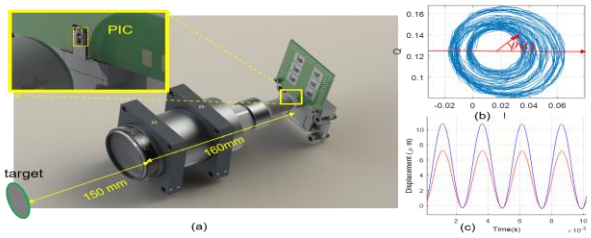

Figure 1: Figure. (a). Schematic show of the LDV setup with integrated PIC and confocal lens. (b) A Lissajous curve of the LDV output. The phase $\theta(t)$ of each point is proportional to the measured displacement. (c) Recovered displacement signals at two different locations of a loudspeaker vibrating at 400 Hz.

References

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