**Wavelength-Modulated Differential Photoacoustic Spectroscopy (WM-DPAS) for Very Early Detection of Breast Cancer and $StO_2$Quantification**

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Biomedical photoacoustic (PA) imaging is a non-invasive imaging modality with unique hybrid optical-ultrasonic principles. Due to a number of advantages that PA enjoys over other biomedical imaging modalities, PA imaging has risen to the top of medical diagnostic procedures such as human breast cancer detection. While conventional PA imaging has been mainly carried out by a high-power pulsed laser, an alternative technology, the *Frequency Domain Photoacoustic Radar* (FD-PAR) is under intensive development at the Center for Advance Diffusion-wave Technologies (CADIFT). It utilizes a continuous wave optical source with the laser intensity modulated by a frequency-swept (chirped) waveform for acoustic wave generation. The small amplitude of the generated acoustic wave is significantly compensated by increasing the signal-to-noise ratio (SNR) by several orders of magnitude using pulse compression and matched-filter correlation processing in a way similar to radar systems. The current study introduces a novel FD-PAR modality for ultra-sensitive characterization of functional information for breast cancer imaging. The talk will introduce wavelength-modulated differential Photoacoustic spectroscopy (WM-DPAS) detection which has been developed to address angiogenesis and hypoxia monitoring, two well-known benchmarks of breast tumor formation. Based on the developed WM-DPAS theory, this modality efficiently suppresses background absorptions and is expected to detect very small changes in total hemoglobin concentration ($C_{Hb}$) and oxygenation levels ($StO_2$), therefore identifying pre-malignant tumors before they are anatomically apparent. The capability of the WM-DPAS to sensitively detect human breast pre-malignancy and quantify the corresponding breast carcinogenesis benchmarks was studied using an *in-vitro* blood circulation system. Comparison of the experimental results to the developed theoretical formalism will be presented and the clinical diagnostic prospects of WM-DPAS will be discussed.