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Parallel detection for picosecond ultrasonics

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Picosecond laser ultrasonics is a powerful technique for measurement and diagnosis of micro- and nano-scale structures. Unfortunately the data acquisition speeds are slow, this is a major drawback for widespread acceptance and usually makes imaging impractical. We are engaged in a program to accelerate the data capture rate by parallel acquisition of the incoming signals. This involves electronic developments as well as optical design. In order to parallelise the electronics we have used two approaches (i) a modified commercial camera and (ii) a custom built CMOS array detector. These approaches use an integrating camera which by application of suitable algorithms can perform the task of parallel lock in detection. Modulation depths below 1 part in 10⁶, over 512 pixels can be readily detected with the commercial detector and smaller modulation depths are possible with the custom detector on account of the large well depth and hence high signal to noise. We also discuss the novel optical detection configurations that allow parallel detection of ultrasonic waves with ultrasonic wavelengths below the optical diffraction limit. Results are presented that show image acquisition rates orders of magnitude faster than normally possible with picosecond ultrasonic systems. Prospects for ultrahigh resolution optical resolution are discussed.