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Contrast agent response to chirp reversal

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We investigate an excitation approach for contrast agents based on chirps. This technique, named chirp reversal, consists in transmitting an up sweep frequency chirp (UPF) followed by a down sweep frequency chirp (DNF). Simulations using a modified Rayleigh-Plesset equation were carried out. Chirps with center frequencies from 1.4 MHz to 2 MHz, pressures from 50 kPa to 200 kPa and frequency bandwidths from 30% to 65% were considered. High speed optical observations and acoustical measurements were performed using individual contrast bubbles of radii from 1 μm to 5 μm and a diluted solution of contrast agent respectively. Simulations showed differences between bubbles' oscillations following UPF and DNF chirps in terms of amplitude and duration. Maximal differences occurred for bubbles that were around 80% and 140% of the resonance size. Bubbles at resonance or far away from resonance provided identical responses to UPF and DNF chirps. Larger bandwidths and higher acoustic pressures accentuate further the difference between the UPF and DNF responses. These findings were confirmed through optical data and acoustical measurements. The results reveal the potential of chirp reversal for contrast agent detection.