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Evaluation of local nonlinearity using time reversal acoustic focusing

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Time Reversal Acoustic Focusing can be used for local assessment of nonlinear properties of media [Sarvazyan A., Sutin A. , JASA, 2004; 115 (5): 2595]. Time Reversal focusing provides high acoustic pressure leading to a nonlinear response localized in space and time. Interaction area of two overlapping focused beams acts as a virtual localized source generating ultrasonic waves with combination frequencies. Measurements of the intensity of this signal allow estimation of the nonlinear parameter in the focal region. The first experiment was conducted in water with spatially varying acoustical nonlinearity produced by a microbubble column or contrast agent Optison. We used two synchronized TRA aluminium reverberators to focus ultrasonic waves with frequencies 660 kHz and 776 kHz. Various parameters such as amplitude and frequency of the primary field, the position and number of emitters, choice of initial excitation (tone burst, binary, shirp-coded) were optimized for the nonlinear signature extraction. The second experiment was conducted in steel samples where surface vibration were measured by laser vibrometer. Excitation frequencies were between 490kHz and 860kHz . These experiments show again that amplitude dependence of nonlinear generated components was slightly less than the product of primary component that is predicted by classical nonlinear theory.