

ACOUSTICS2008/3422
Time Reversal Acoustic focusing using layered membranes structure

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In the recent years numerous Time Reversal Acoustic Focusing Systems (TRA FS) employing various reverberation chambers ("acoustic cavities") accumulating acoustic energy in time were described in the literature. We propose an alternative reverberator composed of a liquid-filled volume comprising a series of spatially distributed membranes with varying thickness in the range from one quarter to half wavelength of ultrasound. Random spatial variation of ultrasound reflection from such membranes leads to randomization of acoustic field that highly improve Time Reversal focusing of the system. A theoretical model of reflections from nonuniform membranes is suggested to evaluate spatial and temporal characteristics of TRA focusing formed as a result of numerous reflections and reverberation of ultrasound propagating through the plurality of membranes. The dependence of focal structure and focused waveform was investigated for suggested structure and their focusing efficiency has been compared with that of the conventional reverberators. In the experiment, the membrane were made of Polyethylene Terephthalate or Nylon thermoformed films.. Ultrasonic signals were radiated by transducers with frequency in the range from 3 to 10 MHz. Experiment demonstrated effective TRA focusing by membrane arrangement that can be used for ultrasound focusing and steering in various minimally-invasive biomedical applications.