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Selective ultrasonic focusing towards an optical contrast agent by use of photoacoustic-guided time-reversal

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We recently demonstrated experimentally that optically absorbing regions embedded at centimetric depths in an optically diffusive medium can be used, through the photoacoustic effect, as ultrasound sources for time-reversal techniques [Bossy *et al.*, APL **89**(18), 2006]. If the optically absorbing region is spatially localized, the emission of the time-reversed photoacoustic waves provides a method to automatically focus ultrasound towards the absorbing region. In biological tissue, this approach has the potential to automatically guide high-intensity focused ultrasound (HIFU) beams towards a targeted region labelled with an optically absorbing contrast agent. However, such an approach is conceivable only if the HIFU beam is guided towards the sole targeted region, and not towards other potentially strong endogenous optical absorbers (such as blood vessels). In this work, we present a method to selectively focus time-reversed photoacoustic waves towards an exogenous wavelength-dependent optical contrast agent. Experiments were performed *in vitro* on tissue-mimicking phantoms, with nano-particles as contrast agents. A tunable nanosecond pulsed laser was used with different optical wavelengths to generate photoacoustic waves. A multi-channel time-reversal ultrasound system was used to emit ultrasound signals derived from time-reversed photoacoustic signals obtained with different optical wavelengths.