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Numerical modeling of the effects of finite size transducers for time reversal acoustics in solid media

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Time Reversal Acoustics (TRA) has been shown to be very robust not only in fluids but also in solid bounded media. The most relevant limitations to the Time Reversal Process (TRP) in solid specimens are the co-existence of several propagation modes, mode conversion at each interface (inhomogeneities or boundaries), attenuation mechanisms and the multidimensional nature of the propagating wave fields. Additional limitations arise in practical applications, for example for Non Destructive Evaluation purposes, when the Time Reversal Mirror (TRM) piezoelectric transducers are usually attached to the surface of the solid. We have investigated the role of the finite size of the TRM transducers and their sensitivity to only certain components of the incident wave fields in the TRP when they are attached to the surface of the sample under study. We have developed a theoretical analysis and performed numerical simulations and laboratory experiments in order to examine the robustness of TRA in solid media, including where the TRM is composed of finite size elements attached to the specimen surface. The results lead to useful information about the efficiency of the TRP as well as the optimization of the TRM setup in terms of transducer size.