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Using Singular Value Decomposition to analyse a low frequency contribution on human cortical bone with a 1MHz axial transmission probe

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The configuration of axial transmission technique dedicated to cortical bone characterization generates multiple contributions, associated with different propagation modes. The first arriving signal velocity is classically evaluated using time-of-flight measurements while the analysis of later arrivals requires the development of specific signal processing tools. We focus here on an Energetic Low Frequency (ELF) later contribution acquired by a 1-MHz multi-element bi-directional probe devised in the LIP. Using a procedure adapted from the Singular value Decomposition (SVD), the ELF contribution was separated from the rest of the signal. The ability of the method to provide an accurate phase velocity estimate of a dispersive wave was established in a controlled-case study on the propagation of Lamb waves on plates using FDTD (Finite-Difference Time-Domain) simulations. The method applied on signals acquired previously in vitro on human radii using the bidirectional device show that the ELF is consistent with the A0 Lamb mode and that its velocity is related to cortical bone thickness ($R2 = 0.6$, $p < 10\text{-}5$). Identification of A0 type wave agree with results reported in the literature obtained with a mono-element device which operates in the 100-300 kHz frequency band.