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Towards a standardized approach for quantifying inertial cavitation activity

Jamie Collin[a], Ian Webb[a], Ronald Roy[b] and Constantin Coussios[a]
[a]University of Oxford, Medical Engineering Unit, 43 Banbury Road, OX2 6PE Oxford, UK
[b]Boston University, Dept. of Aerosp. and Mech. Eng., 110 Cummington St., Boston, MA 02215, USA

Relative measures of the energy radiated as broadband noise emissions by inertially cavitating bubbles, such as the mean square voltage received using a passive cavitation detector (PCD), have been recently shown to be directly relatable to cavitation-mediated bioeffects. Even though numerous techniques exist to detect inertial cavitation qualitatively, there is presently a lack of a unified approach that makes it possible to quantify and compare levels of cavitation activity across different experimental setups and conditions. A technique has been developed that uses a calibrated sound source, a hydrophone, and a point spherical scatterer of known frequency response embedded in a tissue-mimicking material to achieve an absolute calibration of a PCD on receive. This makes it possible to relate the PCD signal during inertial cavitation activity to the acoustic power radiated as broadband noise in the proximity of the bubble cloud. The technique is validated against PCD measurements of single-bubble inertial cavitation activity in a tissue-mimicking material and compared to theoretical predictions using the Keller-Miksis model. Calibrated measurements of acoustic power radiated as broadband noise emissions could thus provide a quantitative measure of cavitation dose that can be directly related to resulting bioeffects, such as increased sonoporation or enhanced heating.