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PHYSICS BASED, VALIDATED RELIABLE MODELING OF SINGLE ELEMENT FOCUSED ULTRASOUND TRANSDUCER (SEFT)

Cristina Pasquinelli[1,2], Hazael Montanaro[3,4], Hyunjoo J. Lee[5], Niels Kuster[3], Esra Neufeld[3], Axel Thielscher[1,2,*]
[1] DRCMR, Hvidovre, Denmark
[2] DTU, Kgs. Lyngby, Denmark
[3] ITIS, Zürich, Switzerland
[4] ETH, Zürich, Switzerland
[5] KAIST, Daejeon, South Korea
*e-mail: axelt@drcmr.dk

OBJECTIVES

Transducer models for the simulation of transcranial focused ultrasound stimulation (TFUS) are often not accurate when only based on the specifications of the manufacturer, but require adaptations based on hydrophone measurements. We investigated the importance of creating a transducer model that is based on a real physical representation of the geometry and internal transducer structure, rather than an 'effective' model optimized to fit hydrophone measurements in water.

METHODS

A SEFT operating at 500 KHz has been characterized through measurements in a water tank with and without obstacles of varying shape (plate, pig and sheep skull) printed from a material with known acoustic properties (Veroblack) at different positions. We compared an 'effective' model with our new physical model accounting for internal structure, using the gamma method (spatial and intensity tolerance: 5mm and 15%). We calculated the percentage of points outside this tolerance (failure %) as well as the deviations of the position of maximum intensity (max) and intensity and the full width at half maximum (FWHM).

RESULTS

The results are shown in the Table.

CONCLUSIONS

While 'effective' transducer models can well reproduce the acoustic distribution in water, they are significantly less accurate than physical representation-based models when obstacles are introduced.

		Failure [%]	Deviation (% normalized by tolerance) of		
			Position of max	FWHM	Intensity
Water background	Effective model	0.4	-88	-157	-
	Physical model	0	-28	37	-
Obstacle plate	Effective model	19	-135	-220	-77
	Physical model	0	-72	-57	5.4
Sheep skull	Effective model	4	-100	-88	-17
	Physical model	0	-92	38	-42
Pig skull	Effective model	25	-42	-	-284
	Physical model	0	-41	-	100

TABLE: Results of the comparison. In one case the obstacle was too close to the focus to measure the FWHM. The deviations are normalized to the chosen tolerances, i.e. values outside the range from -100 to 100 exceed the tolerance limits.