SIMULATION-LED DESIGN FOR OPTIMIZATION OF INNOVATIVE ACOUSTIC PHANTOMS AND THE ICE CATHETER CALIBRATION METHOD

E. Adawi[1], M.Sc., R. Peled[1], Ph.D.

1. Systems Engineering (Research and Development) Department, Biosense Webster (Israel) Ltd., Yokneam, Israel

INTRODUCTION: The Biosense Webster SOUNDSTAR® Catheter enables registration between ultrasound images and magnetic maps of cardiac cavities in electrophysiology procedures. The catheter comprises an acoustic transducer and a magnetic sensor. A calibration procedure is required to correlate the locations, ensuring accuracy. The main objective is to optimize an innovative acoustic phantom design and calibration method, by adapting them to the catheter characteristics.

Figure 1. SOUNDSTAR® Catheter (left) and its tip (right)

COMPUTATIONAL METHODS: 2D models were developed using the COMSOL Multiphysics® Pressure-Acoustic. Both transient and frequency domain interfaces were used to analyze the pressure field and plane wave propagation, and the scattered field from differing targets. The analysis included near and far fields. The comparisons were made between differing geometrical shapes, sizes, and distances from the transducer. The study included analysis of the near and far fields, by means of reflectivity, RCS (RADAR Cross-Section), and reflection directivity.

RESULTS: $f = 5\text{MHz}, \lambda = 0.3mm, T = 25°C$

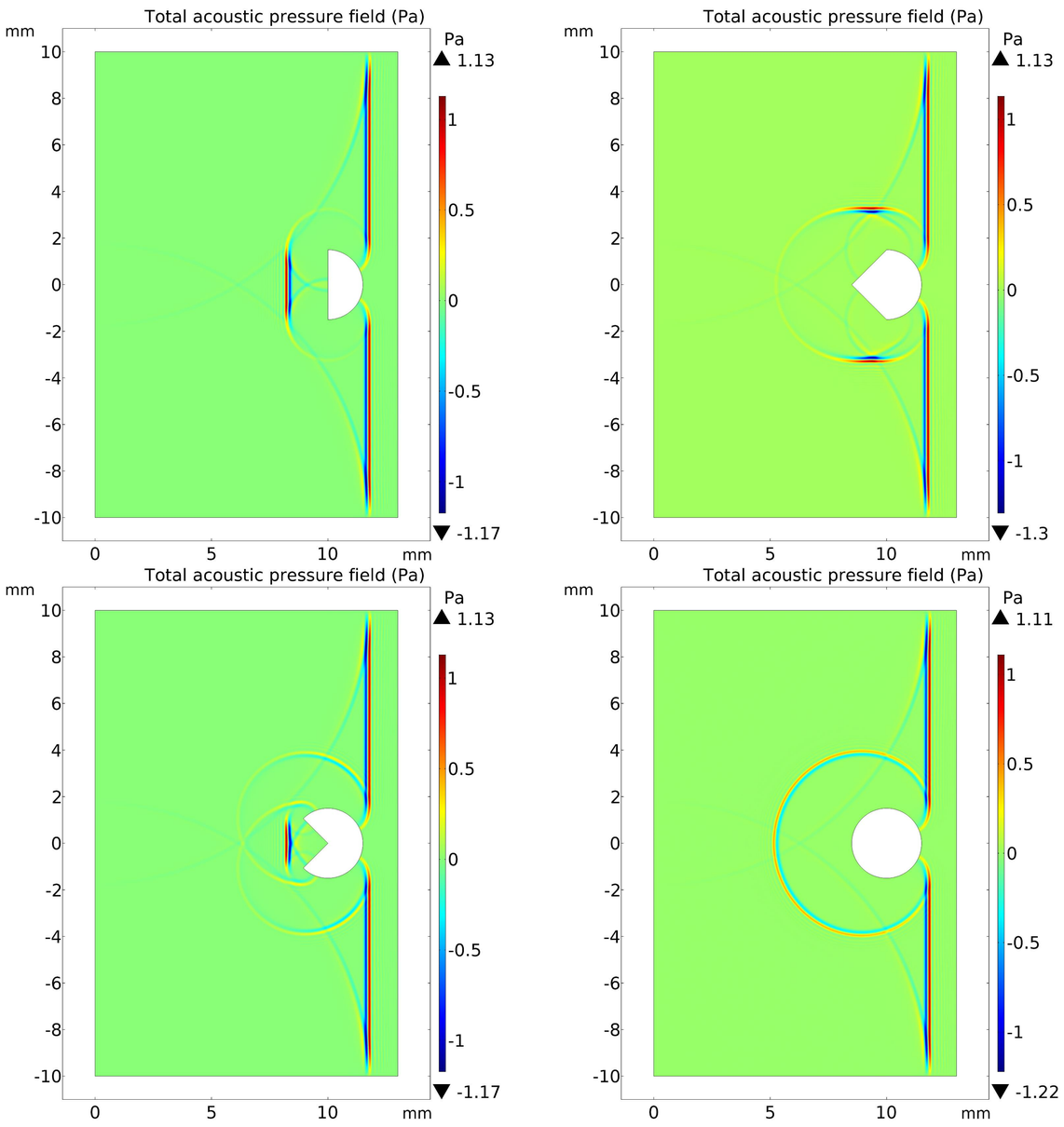

Figure 2. Transient acoustic pressure reflection

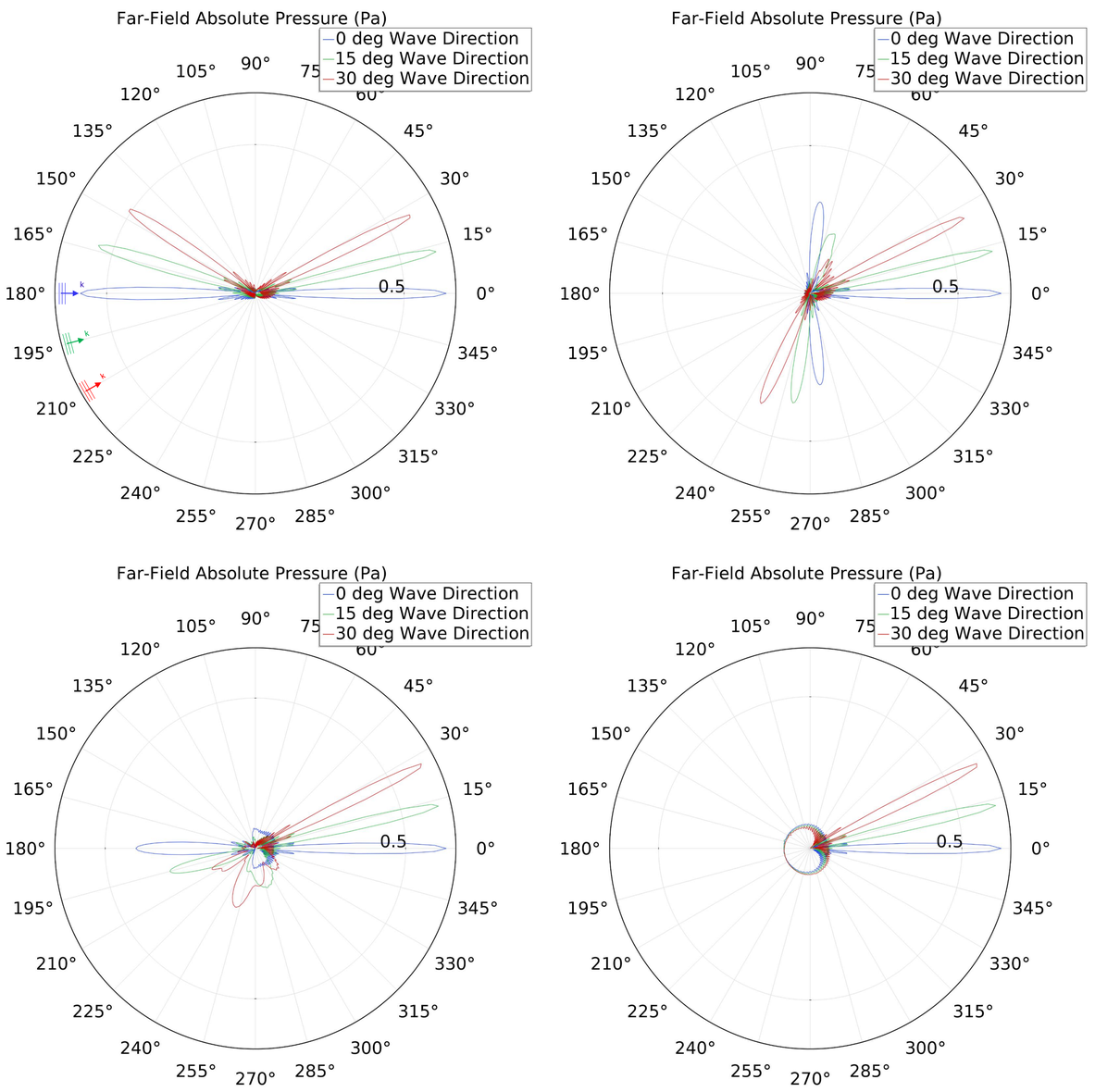

Figure 3. Scattered pressure RCS, as a function of the incident angle

CONCLUSIONS: An optimal target was found to be minimal (smaller than the beam-width) and yet larger than λ (to avoid interferences), with a rounded rough surface (that is sub λ for diffuse reflection), made of a hard-acoustic material, and perpendicular to the ultrasound fan. The target is designed to appear as a dot in an ultrasound image that enables automatic and accurate target identification, simplifying the calibration, and reducing user dependency. The research led to the development of an innovative calibration technique that yields significant improvements in ICE catheter calibration, and a new patent application.

Pending Patent

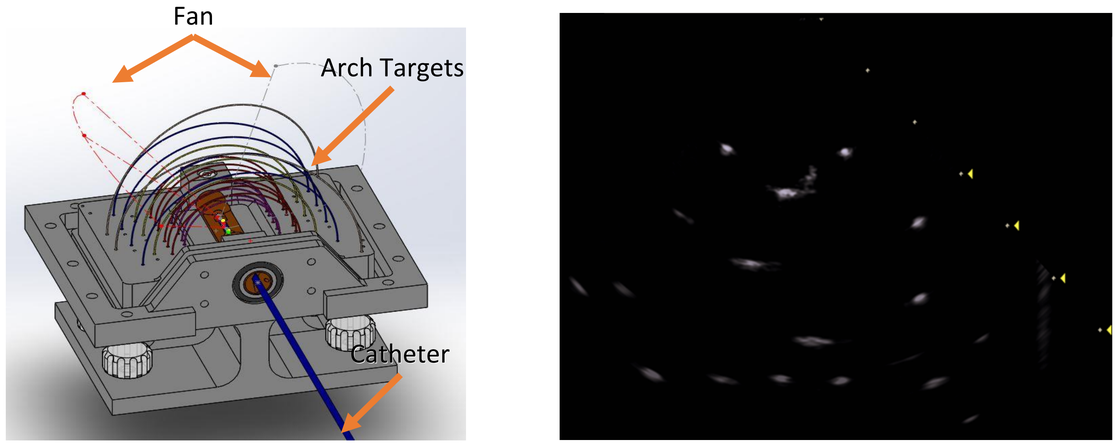

Figure 4. Arch target phantom (left) and its ultrasound image at $8MHz$ (right)

REFERENCES:

1. E. Adawi et al., “SIMULATION-LED DESIGN TO OPTIMIZE INNOVATIVE ACOUSTIC PHANTOM DESIGN AND CALIBRATION METHOD, FOR INTRACARDIAC ULTRASOUND LOCALIZATION CATHETER”. U.S. Provisional Application No. 62/684942, June, 2018.
2. R. Peled, E. Adawi et al., “ACOUSTIC PHANTOM AND METHOD FOR INTRACARDIAC ULTRASOUND LOCALIZATION CATHETER”. U.S. Patent Application No. 16/123012, September, 2018.

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Excerpt from the Proceedings of the 2018 COMSOL Conference in Lausanne