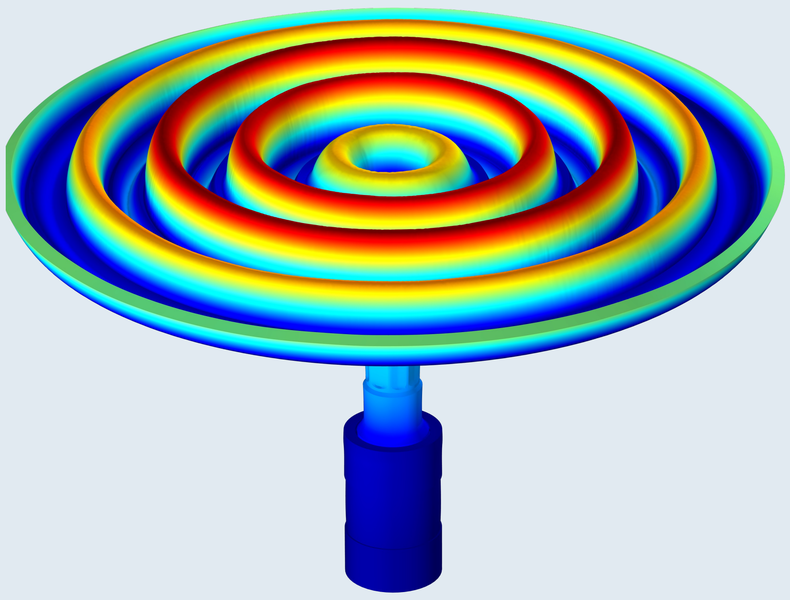

Design of an Airborne Ultrasonic System with High SPL, Large Focusing Range

Approach the issue of air acoustic impedance mismatch through the design of a large vibrating disc, operating at 20kHz, with special beam focusing performance.

Design a spherical array of 5 units to reach Sound Pressure Level of 160dB at 3 meters focus distance

L. Spicci
Everywave Srl, Villa del Conte (PD), Italy.

Abstract

This work reports the FEM design of a high-power ultrasonic system, capable of emitting acoustic radiation at 20kHz with SPL peaks up to 160dB. Such pressure level can be found as a requirement for some special industrial applications ([1],[3]), like foam reduction or gas processing. An important design issue for high power airborne ultrasonic systems lies in the air low acoustic impedance, resulting in poor power transfer.

The best solution was found to be an array of special ultrasonic radiators that lie on a spherical surface whose center is the required focus of the system.

Each unit is a high-power ultrasonic device, operating at 20kHz and connected to a disc sonotrode optimized for ‘in-phase’ radiation across its entire surface [1].

FIGURE 1. Left: Single unit, Ultrasonic Converter – Booster – Disc. Right: spherical array , 5 units

Methodology

The spherical array was designed with 3D COMSOL Multiphysics®-Acoustics FEM, employing many features to cut calculation load and get the best results:

- A portion of the electro-mechanical system is modeled, and symmetries are set on boundaries.
- Acoustic domain is limited to the surrounding of the discs, PMB (Perfectly Matched Boundaries) are set on borders and external pressure calculation is performed (Helmholtz-Kirchhoff integral).
- Only the discs are modeled as structural mechanics parts, excited at the resonant frequency found in previous step (mechanical) to generate the corresponding acoustic field

Results

The optimized array system is capable of :

- SPL of more than 160 dB on axis , at focus
- focus distance as high as 3 meters from the system
- good directivity with a strong and narrow center lobe of radiation

Finally, it must be noted that all performances reported here are achievable with acceptable electrical powers, that never exceeded 1kW for each unit.

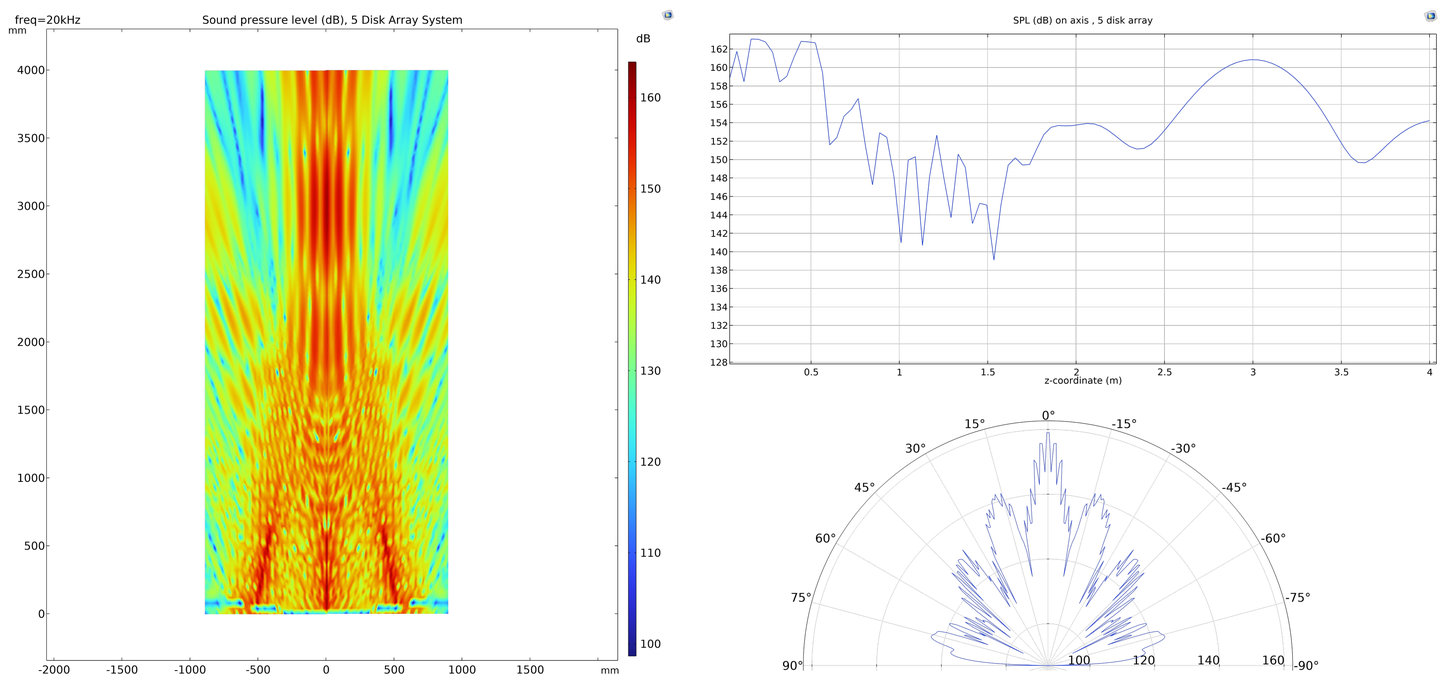

FIGURE 2: SPL on 2D section plane / SPL across axis / directivity

REFERENCES

1. Power ultrasonic transducers with vibrating plate radiators, *J.A Gallego-Juarez et al.*
2. Advanced technique to reduce emissions of fine particulate matter using ultrasounds*, B. Bergmans et al.*