Exercise 12: Radiation by a loudspeaker box

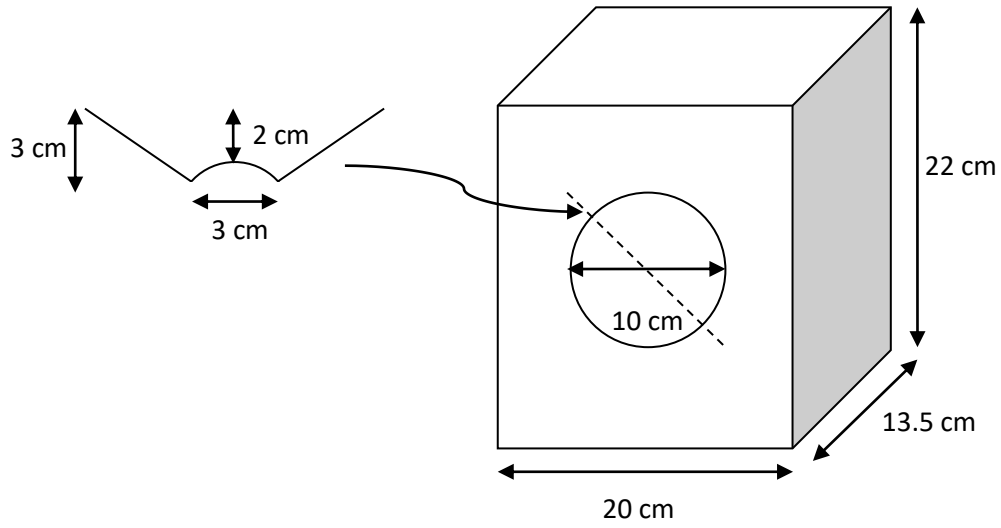

Figure 1. Dimensions of the loudspeaker box.

In this exercise, you will compare a measurement in the anechoic chamber with a simulation using the Boundary Element Method. The setup is a loudspeaker box of the closed type (no vent) and a simple rectangular shape, as shown in figure 1. Its response will be determined at positions in a circle at some distance away (1,5-2 m) in a horizontal plane centered on the loudspeaker's diaphragm.

Measurement in the laboratory

This is the measurement procedure for your information. Provided results can be used instead. The measurement setup consists of:

- Loudspeaker box
- PC-based measurement system
- Measurement microphone
- Audio amplifier
- Turntable with control unit
- Laser vibrometer

The turntable can be programmed to execute angular steps of any size. If you do not have a turntable, you can make the measurements manually, one angle at a time. Choose enough resolution (5-10 degrees). Store the results.

Perform a laser measurement of the velocity of the diaphragm as a function of frequency. This will be the boundary condition for your numerical simulation.

Numerical simulation

This setup is simulated using a three-dimensional modeling tool. A script has been prepared in 3D BEM. Go through the script and understand the steps.

In 3D OpenBEM there is no mesh generator included, and an external meshing program is needed. We use GMSH, an open-source meshing program (http://geuz.org/gmsh/). The script file in GMSH format describing the loudspeaker box is included in the package. **Download GMSH, load the file and try to modify it**. You may change the mesh algorithm, mesh density or add features, like the suspension.

The script *test_loudspeaker* calculates the same setup that was measured in the laboratory. Go through it and make changes. **Pay attention at the way the velocity boundary condition is implemented**. Explain why.

Comparing results

Compare measurement and simulation. You may compare:

- The directivity pattern for a given frequency.
- The frequency response at a particular position.

Be aware of the limitations of model and simulation. **What are we assuming? How will these limitations show in the results?**

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