COMSOL CONFERENCE 2014 CAMBRIDGE

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Modelling the Sound Radiation by Loudspeakers Cabinets

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Introduction

Loudspeaker cabinets should not contribute at all to the total sound radiation, but aim instead to be a perfectly rigid box. Two phenomena contribute to the total SPL radiated from the cabinet: the acoustic field exciting the wall vibration and leaking by transmission through the wall, and the direct mechanical excitation of the cabinet by the reaction force related to the drive units operation, the subject of this research.

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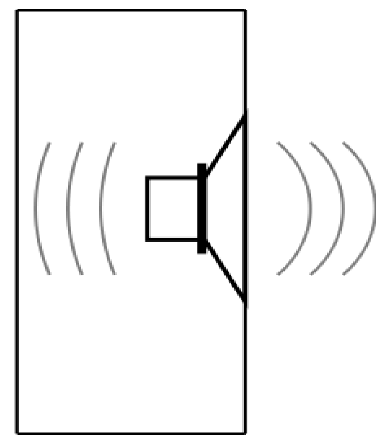
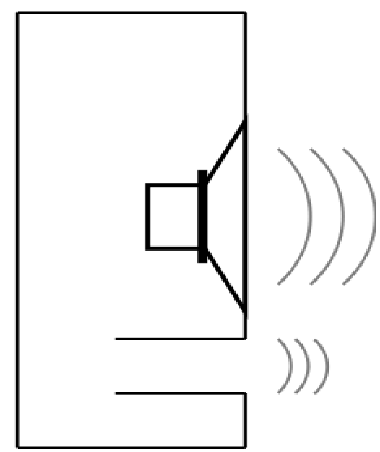
Why do we need a cabinet?

- Close box: avoid acoustic short circuit

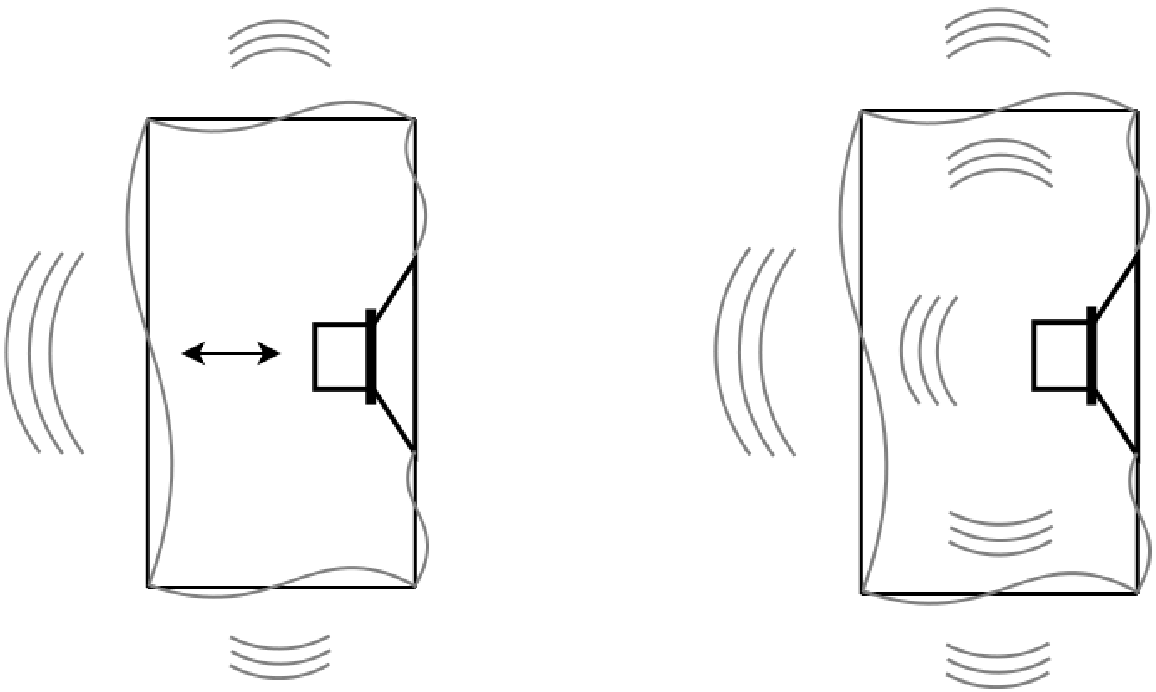


- Bass reflex box: avoid acoustic short circuit and increase bass output at the port tuning frequency



How do they affect the sound quality?

- Unless infinitely heavy and stiff, all structures vibrate and radiate sound



Mechanical effect **Acoustical effect**

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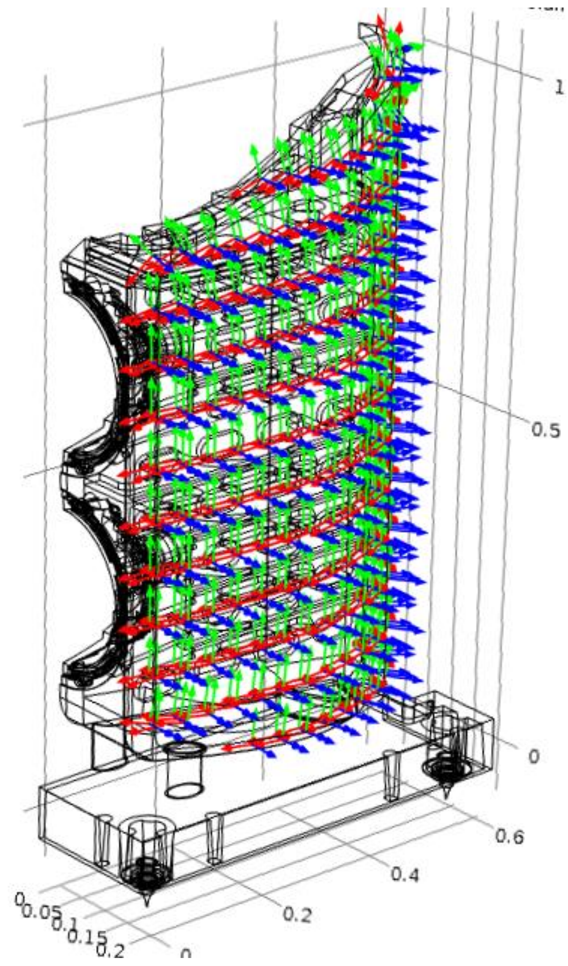
The cabinet under investigation: 800D



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Computational Methods

A 3D model of the cabinet was simulated in three steps:

- Stationary study to solve the curvilinear coordinate system used for the orthotropic properties of the wrap (diffusion method)

- Solid mechanics - Eigenfrequency study and Frequency Modal Domain study

- Solid mechanics - Frequency Domain study

Due to the left-right symmetry of the system, only half of the structure is used. Thin Elastic Layers are used to simplify the joints modelling. The model is constrained with a “Fixed Constrain” boundary condition at the spikes tips, and excited applying a force to drive units motors.

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Materials

The materials used in the assembly are:

- curved plywood external wrap
- internal MDF stiffening panels (Matrix™),
- Aluminium plinth and drive unit chassis
- Steel and Neodymium loudspeaker motor
- Water based glue joint

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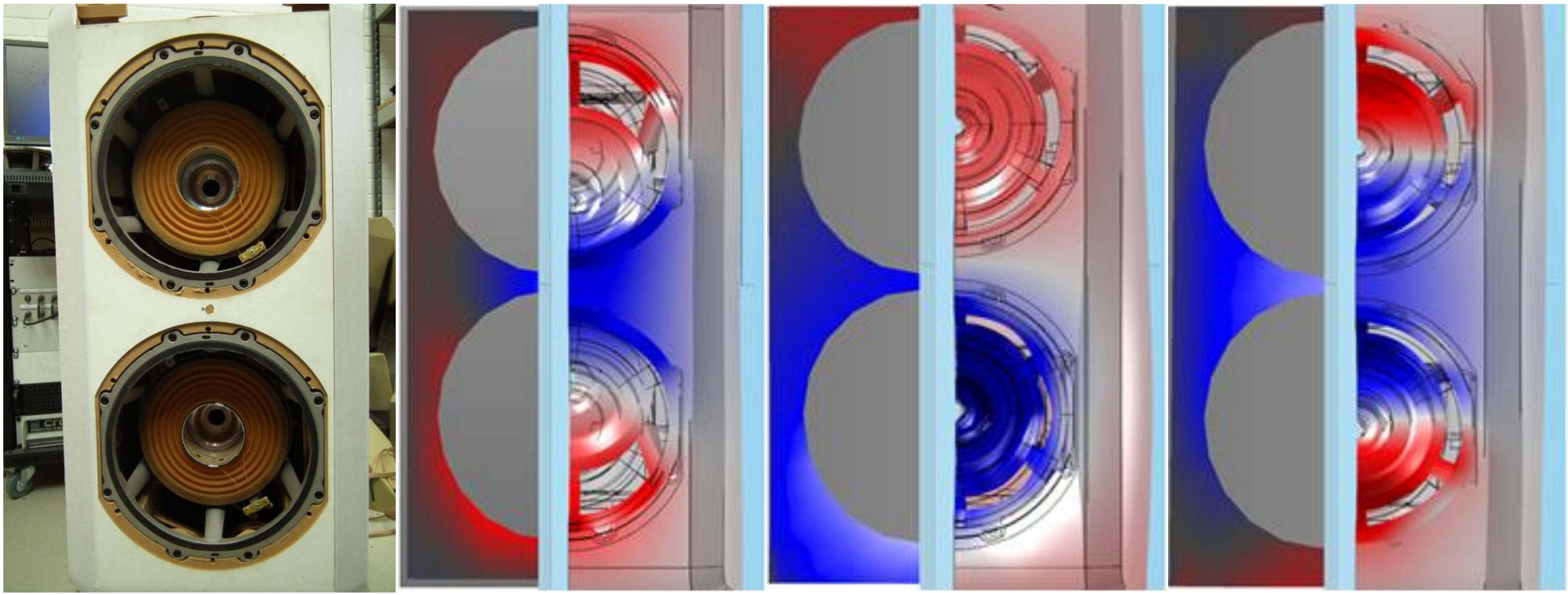
Results /1

- The purpose built drive units were driven while the velocity of each point on a user defined grid over the wrap and front baffle (the two largest radiating surfaces thus the most important) were measured with a Polytec laser Doppler scanning system. The measured modal shape and frequency, on the left, are compared below to the predicted data, on the right, for the front baffle, for the first relevant modes.

Results /1



Purpose built drive units on the left, and the first three vibration modes of the baffle at 222/281Hz, 313/466Hz, 603/690Hz

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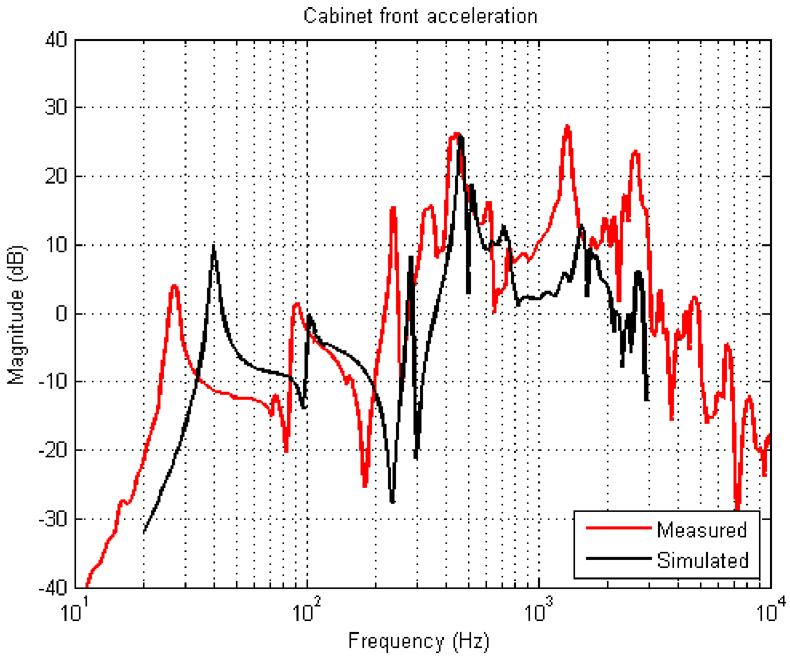
Results /2

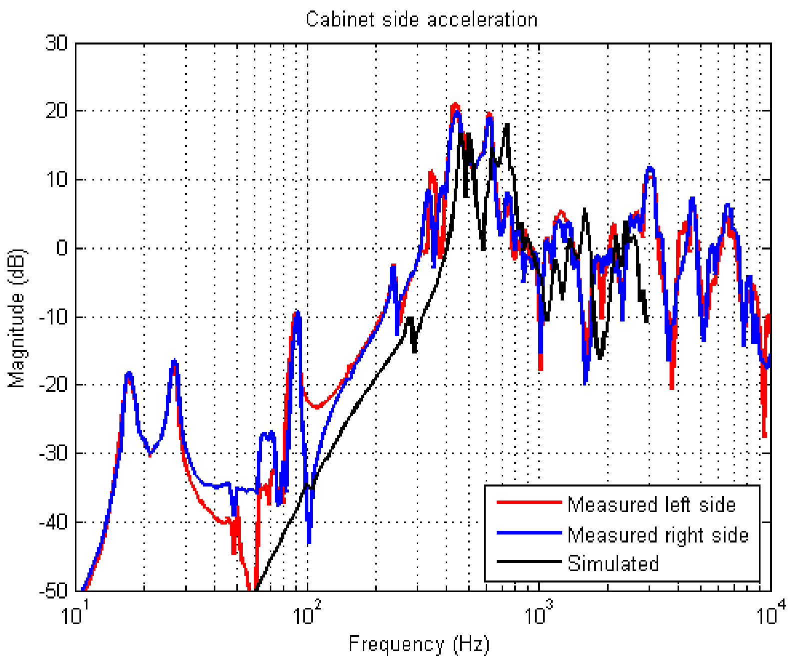
- As comparing animated simulated forced responses to measured responses can be visually misleading, the measured and predicted acceleration magnitude spectra were also overlaid for two critical locations (cabinet front baffle and middle of side baffle)

Results /2



cabinet front acceleration

cabinet side acceleration



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Conclusions

- Simulated accelerations show good agreement with measured results; the model is able to accurately predict trends even if overestimating the resonances frequency values. Further work should be aimed at improving the accuracy of modes frequency values prediction and evaluating through simplified BEM formulations the total acoustic power radiated by the cabinet.

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