PA Loudspeaker System Design Using Multiphysics Simulation

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Introduction: Public Address Loudspeakers need extra design considerations if compared with normal speakers. Coverage over a certain frequency range it is important and COMSOL has the capabilities to do a whole system design simulation keeping prototype times at a minimum.

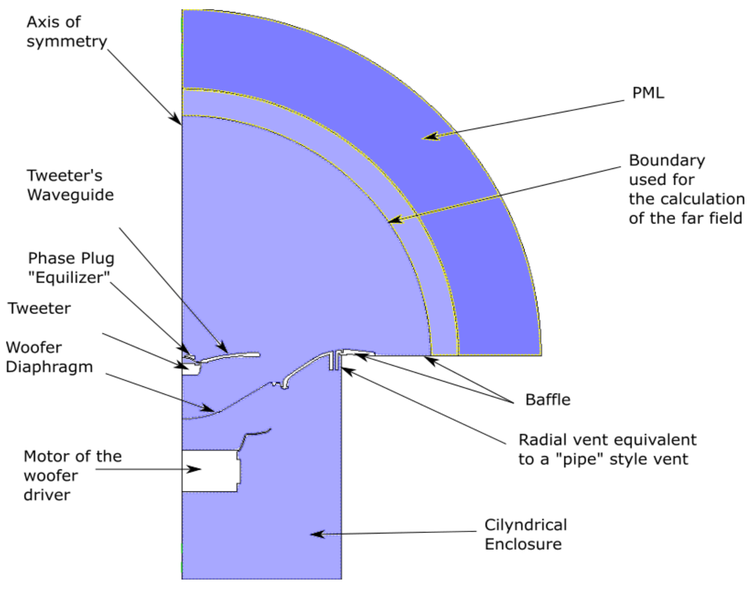

Figure 1. The model

Computational Methods: The simulation uses lumped circuit equivalents for the electrical to mechanical domain, (AC/DC module) and then applies the relative acceleration to the diaphragm boundary, where solves the Helmholtz equation (Acoustics module).

$$\nabla \cdot \left(-\frac{1}{\rho_c}(\nabla p_t - \mathrm{q}_d) \right) - \frac{k_{\mathrm{eq}}^2 p_t}{\rho_c} = \mathrm{Q}_m$$

The circuit below is one side involving the woofer side including a second order low pass filter.

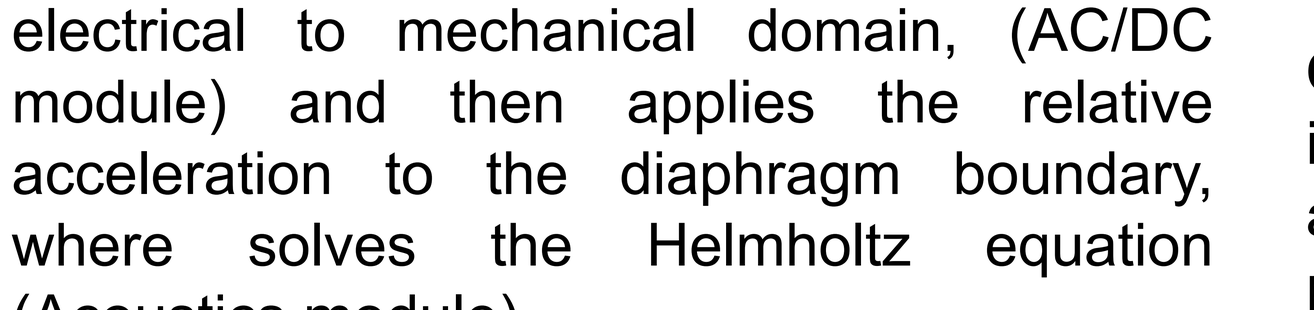

Figure 2. Circuit Equivalent

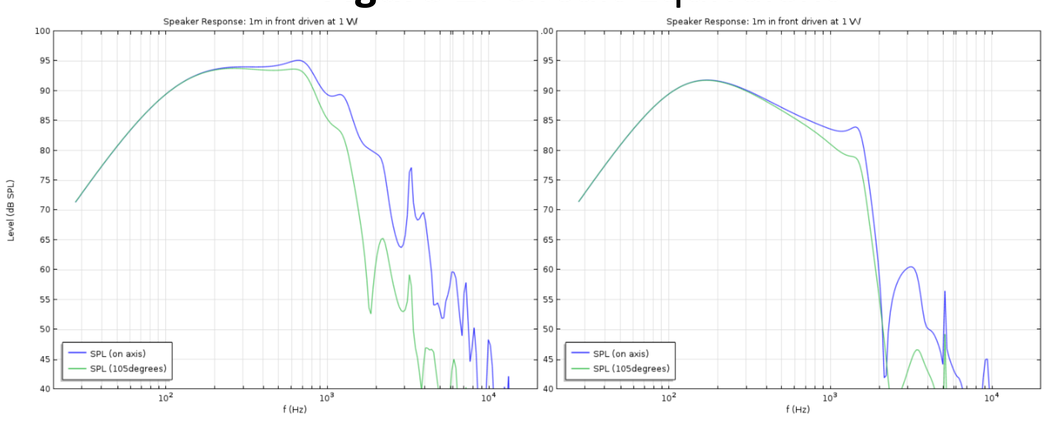

Figure 3. Simulated response for two different woofers and filters

Results: The whole system can then be simulated and optimized with the ability to display graphs that are otherwise measured at great cost in term of resources and time.

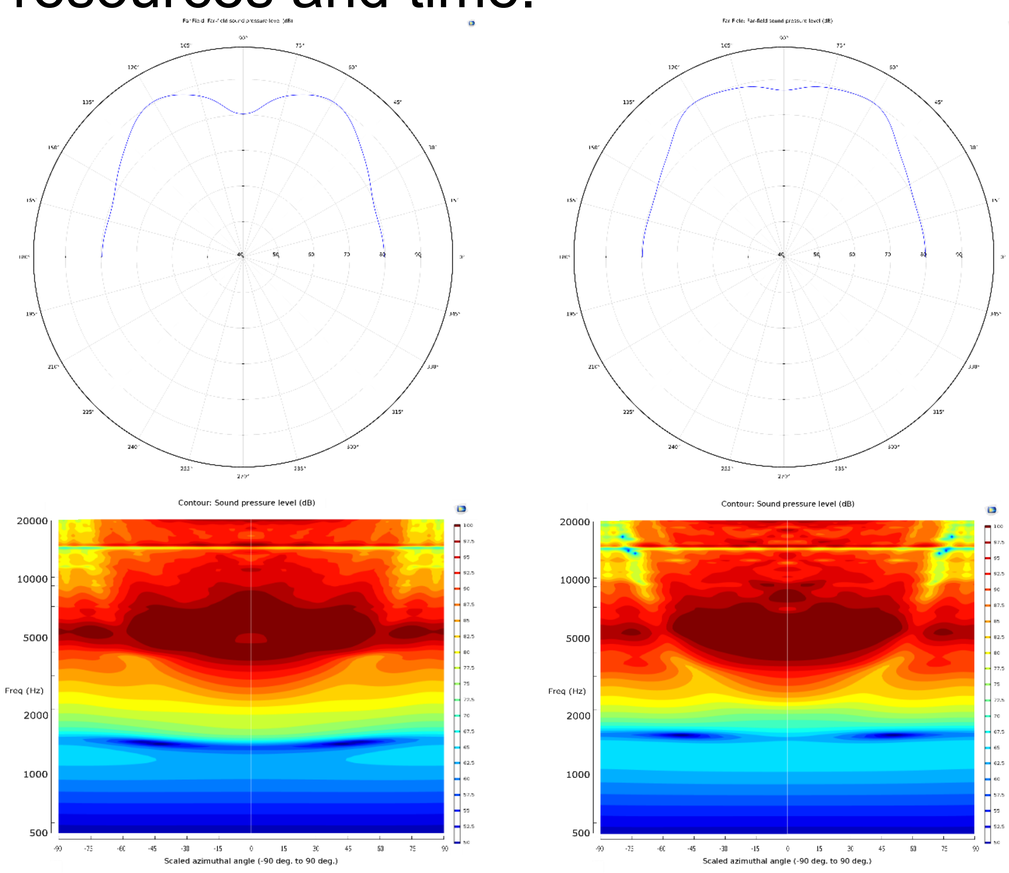

Figure 4. Polar@6.2kHz and mapped response during design before (left) and after optimization (right)

Conclusions: Beside being an excellent investigative tool, results of the simulations are close to the measurement cutting prototype work and resource investment.

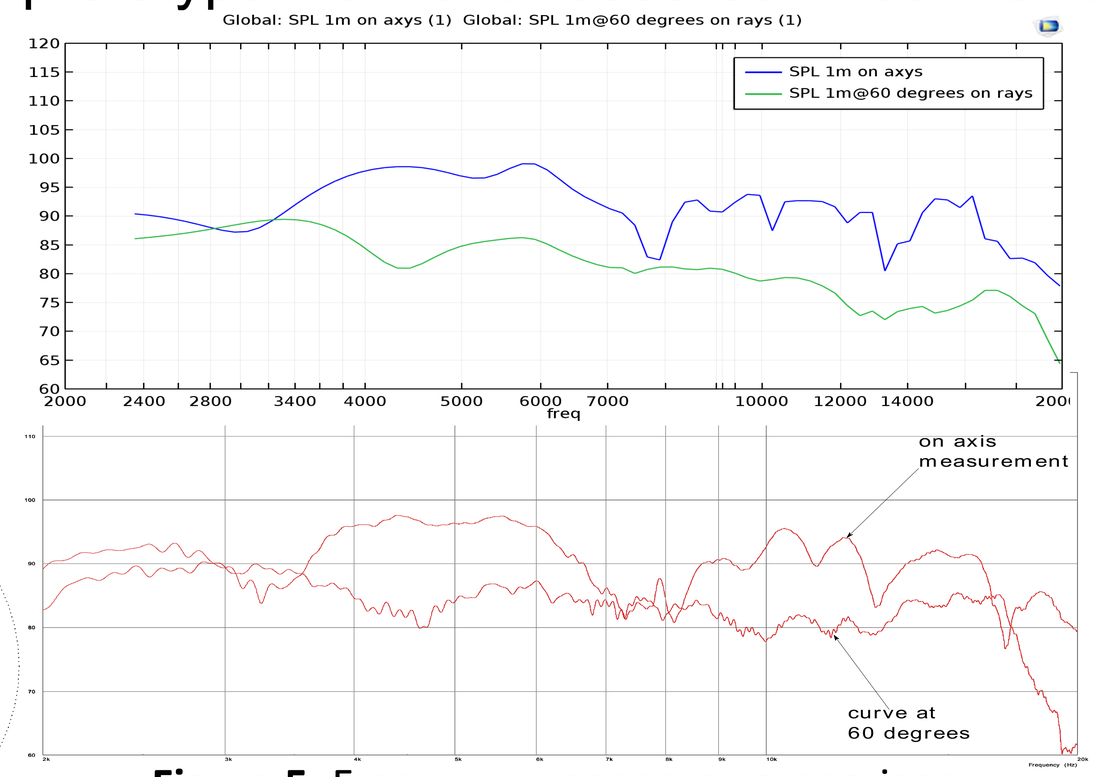

Figure 5. Frequency response comparison

References:

1. L. L. Beranek, Acoustics, the Acoustical Society of America (1993)
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4. M. Kleiner, Electroacoustics, CRC Press (2013)