Compression Driver Simulation Including Air Damping in Phase Plug

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Excerpt from the Proceedings of the 2011 COMSOL Conference in Stuttgart

Agenda

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- Simulation Goal
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Who We Are?

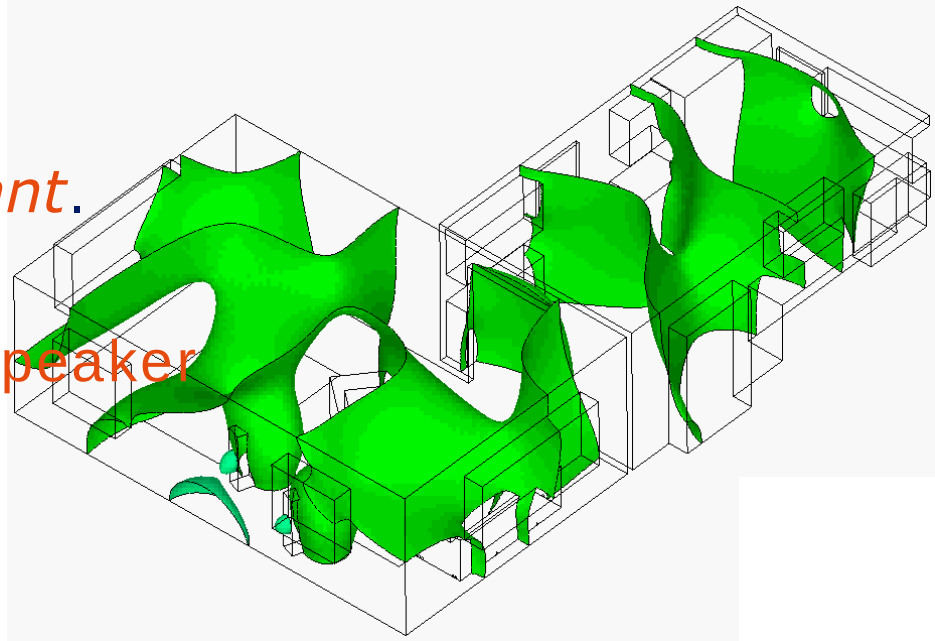
iCapture provides consulting in the field of multiphysics:

- Electromagnetic
- Vibroacoustic &
- Structural Dynamic

product development & simulations.

Since 2011 iCapture is a *Certified COMSOL Consultant*.

Work in medical, wind, loudspeaker and other industries.



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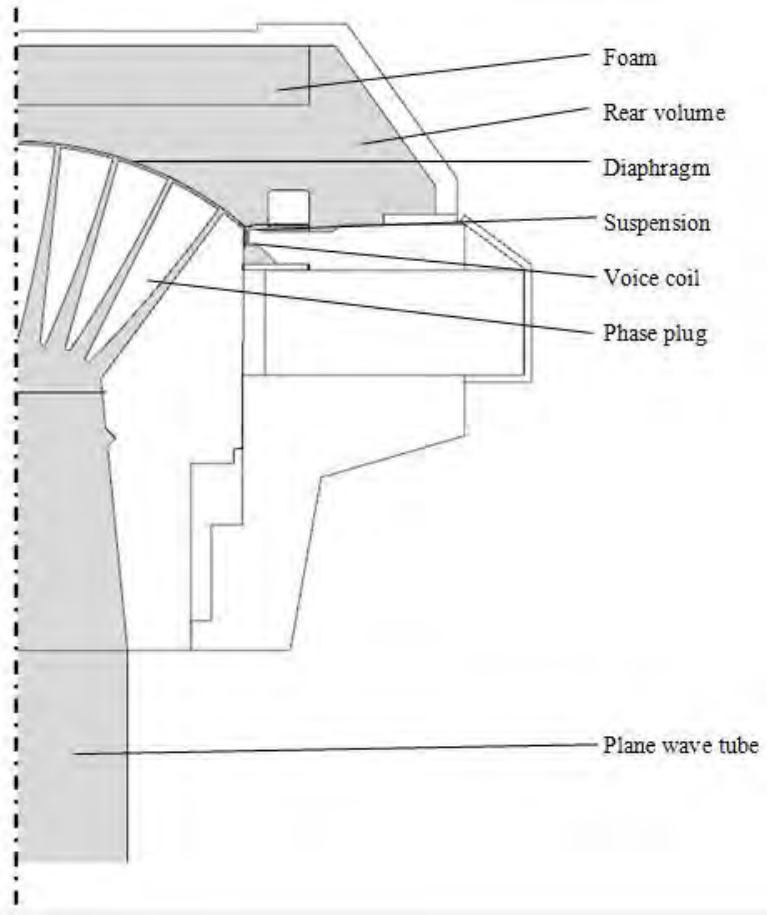
Compression Driver Overview



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Simulation Goal

The simulation goal is to obtain a fully coupled vibroacoustic finite element model of a compression driver including porous and viscothermal damping effects.

The implementation uses:

- the Acoustic-Solid Interaction Module and
- the Thermoacoustics Module

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Viscothermal Damping Effects

Damping due to viscosity and thermal conduction:

- Isothermal at boundary
- Zero velocity at boundary

T=0

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Viscothermal Damping Effects

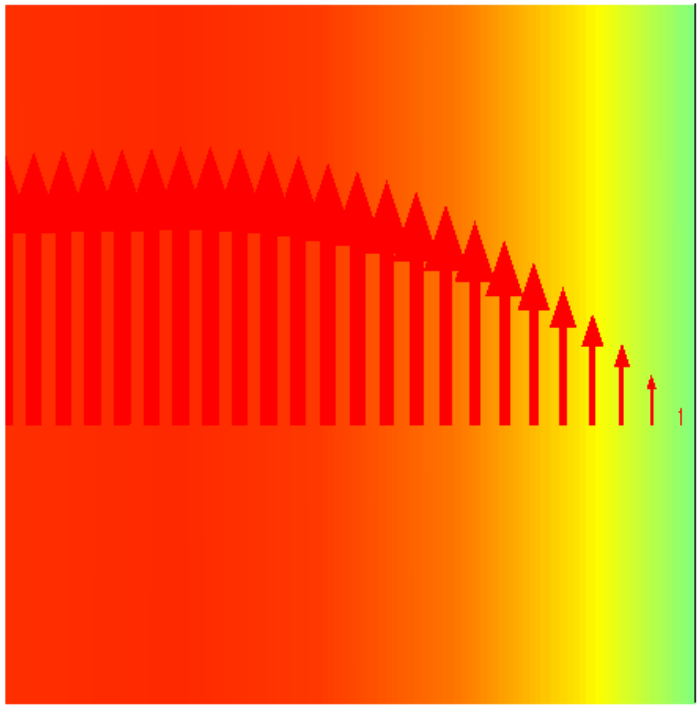
Damping due to viscosity and thermal conduction

- Isothermal at boundary
- Zero velocity at boundary

Viscous boundary layer thickness:

$$d_v = \sqrt{\frac{2\mu}{\rho_0 \omega}}$$

- **μ is viscosity**
- **ρ_0 is the fluid density**
- **ω is the angular frequency**



v=0

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COMSOL implementation

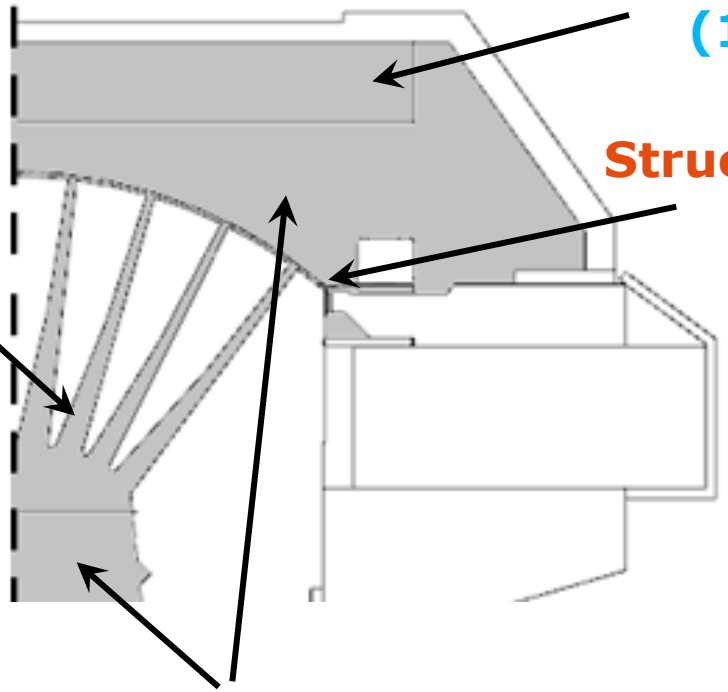
Solve for velocity, pressure, temperature & displacement

Thermoacoustics (4 DOFs)

$$\overline{\mathbf{v}} = \mathbf{v}e^{i\omega t}$$

$$\overline{p} = p_0 + pe^{i\omega t}$$

$$\overline{T} = T_0 + Te^{i\omega t}$$



Porous Acoustics (1 DOF)

Structural Mechanics (2 DOFs)

Acoustics (1 DOF)

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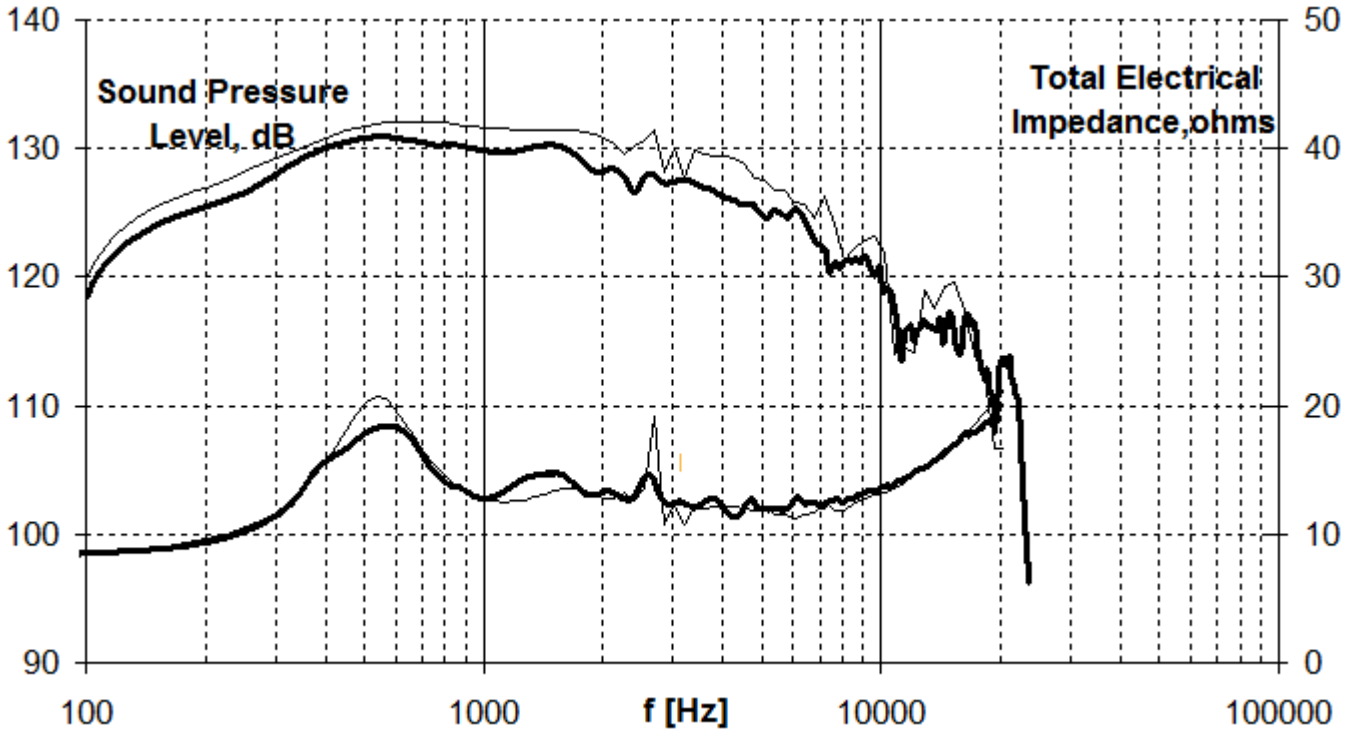
Results

Excluding viscothermal damping



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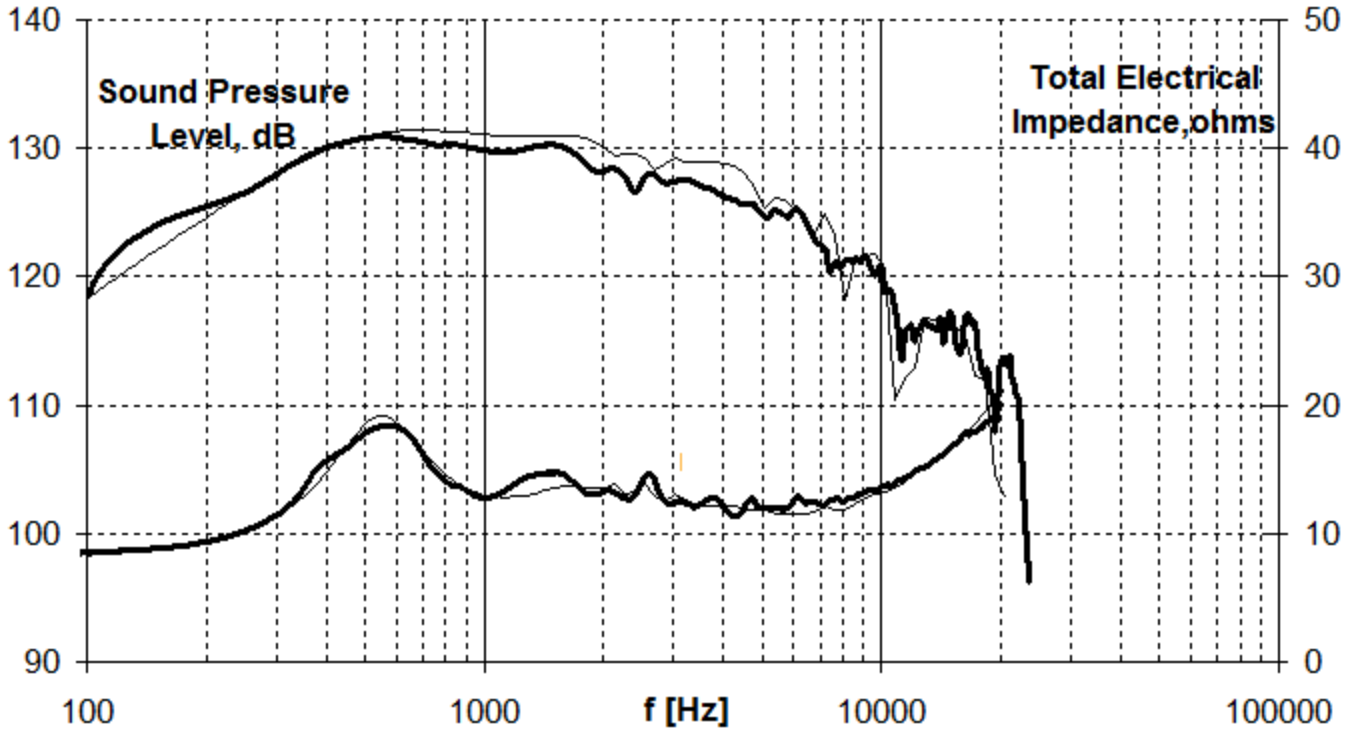
Results

Including viscothermal damping



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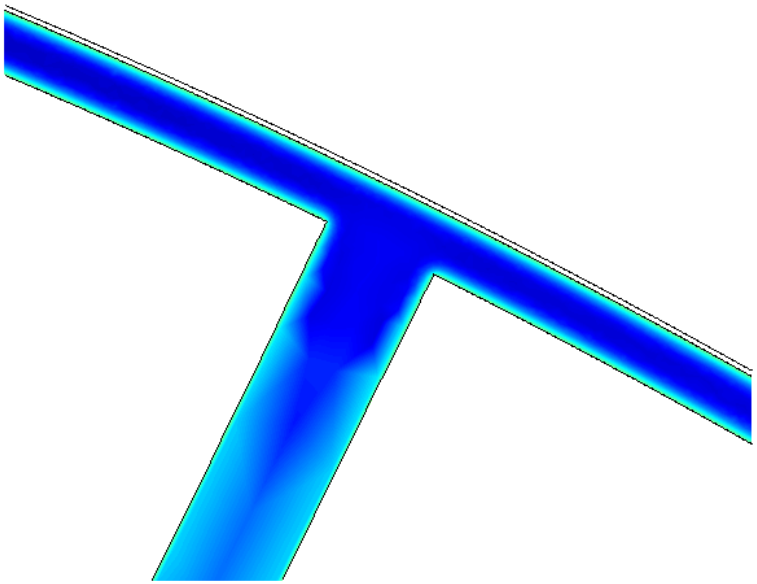
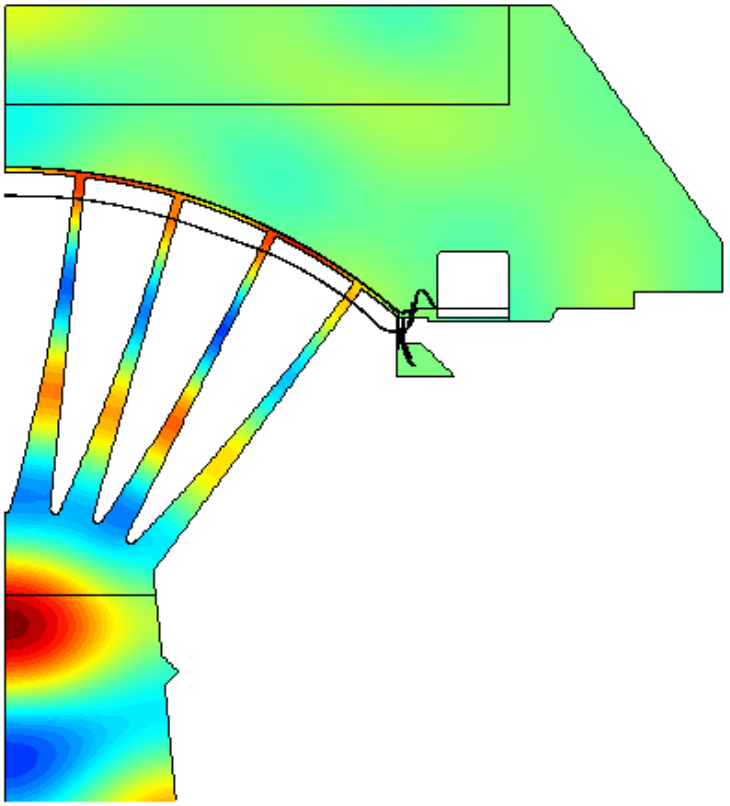
Results

Visualization of results

Temperature variation at 712 Hz



Pressure variation at 12 kHz



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Conclusion

It is possible to do a fully coupled vibroacoustic model of a compression driver including viscous, thermal and porous damping effects.

Benefits of this complex model is:

- extraction & visualisation of the all the involved physics
- different model parameters can be investigated, e.g. different diaphragm materials and geometries.

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