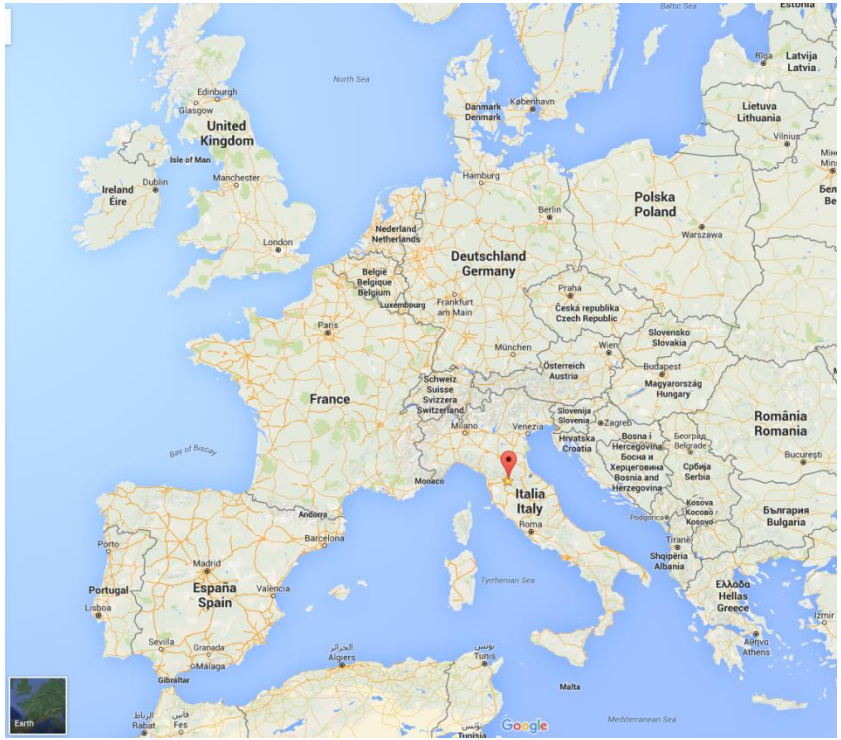
A Multiphysics Approach to the Design of Loudspeaker Drivers

Roberto Magalotti
B&C Speakers

COMSOL CONFERENCE 2015 GRENOBLE

B&C Speakers



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Berlin
Polska
Poland
Warszawa
Nederland
Netherlands
Deutschland
Germany
België
Belgique
Belgium
Luxembourg
Frankfurt am Main
Praha
Česká republika
Czech Republic
Paris
München
Wien
Slovensko
Slovakia
Österreich
Austria
Budapest
Magyarország
Hungary
Schweiz
Suisse
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Switzerland
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Zagreb
Hrvatska
Croatia
Bosna i Hercegovina
Босна и Херцеговина
Bosnia and Herzegovina
Београд
Belgrade
Србија
Serbia
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Romania
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Tiranë
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България
Bulgaria
Andorra
Barcelona
Porto
Madrid
Portugal
Lisboa
España
Spain
Valencia
Tyrrhenian Sea
Ελλάδα
Hellas
Greece
Izmir
Αθήνα
Athens
Sevilla
Granada
Málaga
Gibraltar
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Rabat
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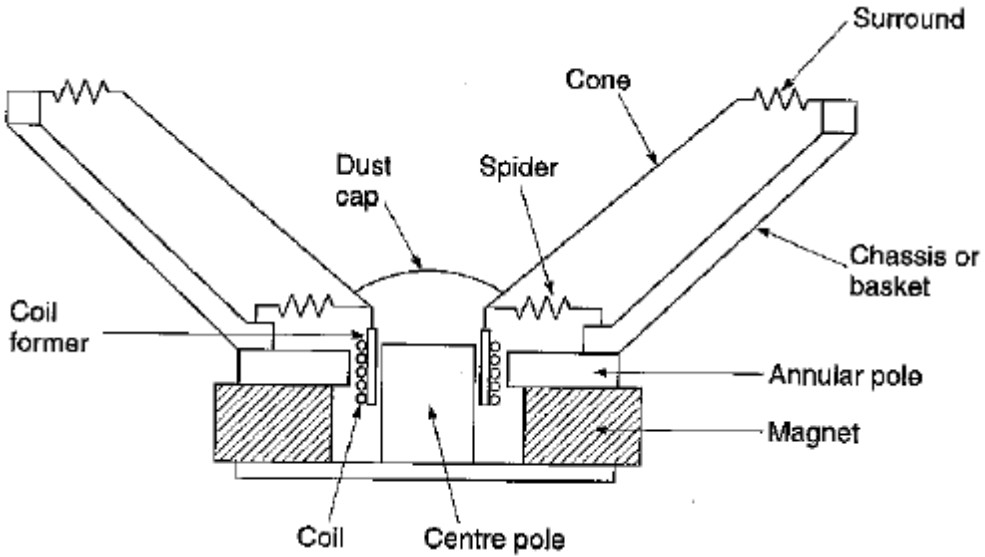
Earth
Google

Loudspeaker drivers and systems

The dynamic loudspeaker (1925 - …)

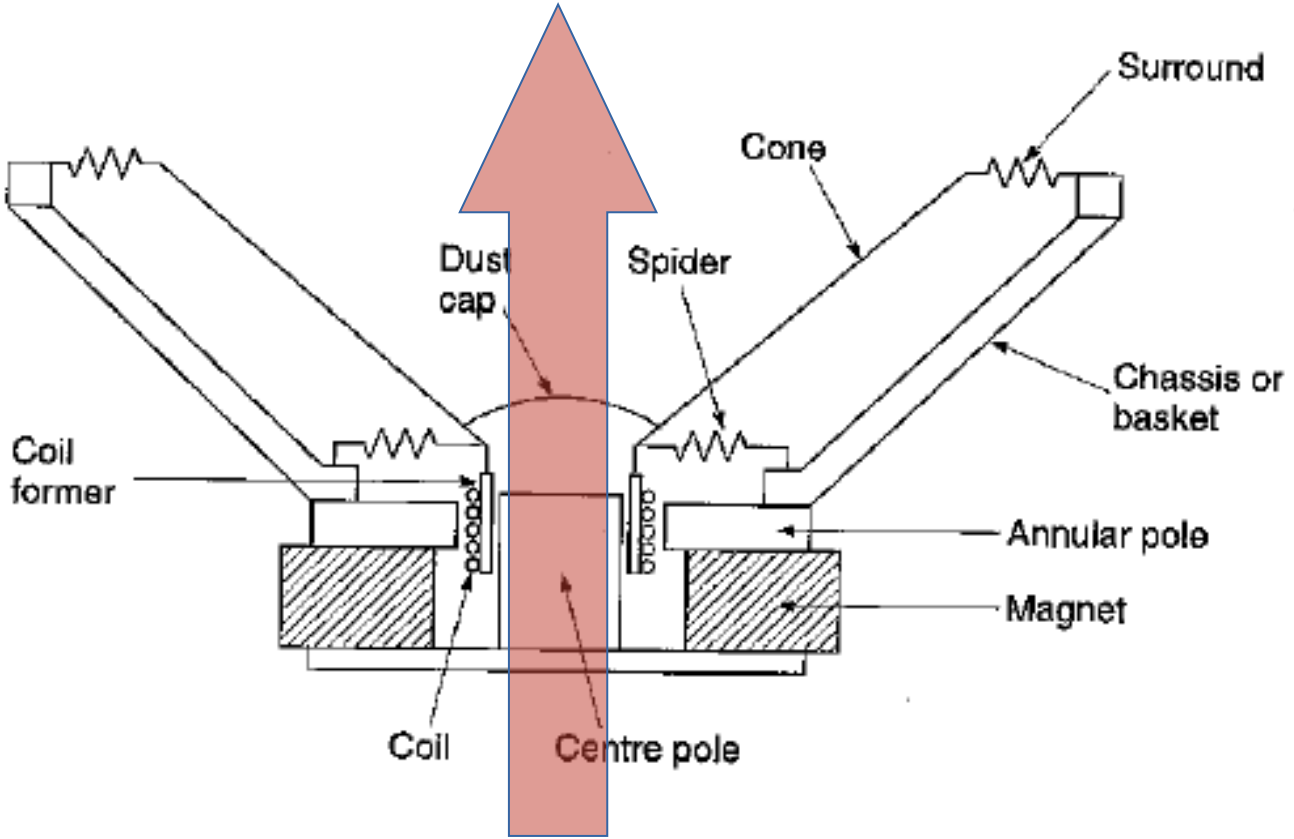


A multiphysics device

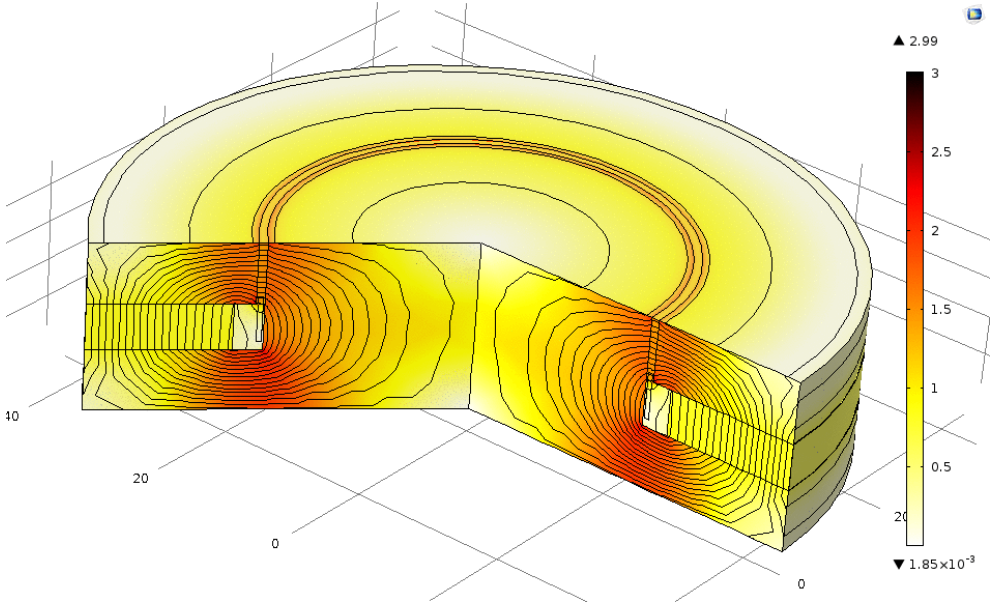
- Electro – mechano – acoustic transducer
- Electromagnetism
- Mechanics
- Acoustics
- Thermodynamics
- ...

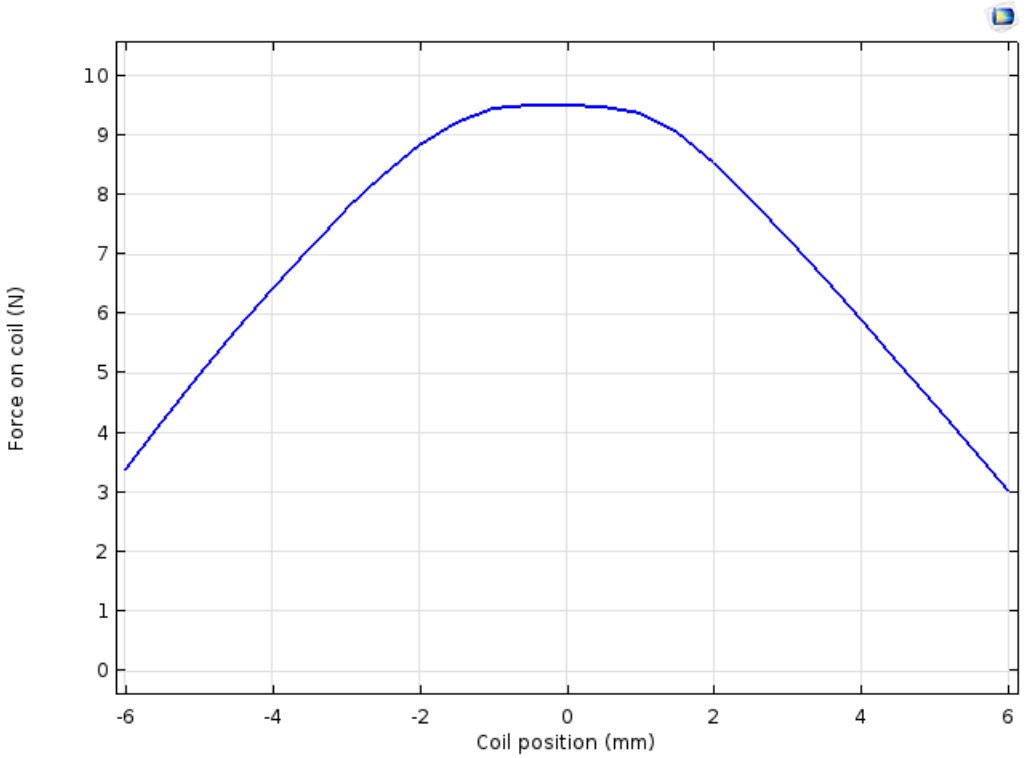
Can FEA cope with all that?

From electrical audio signal to sound

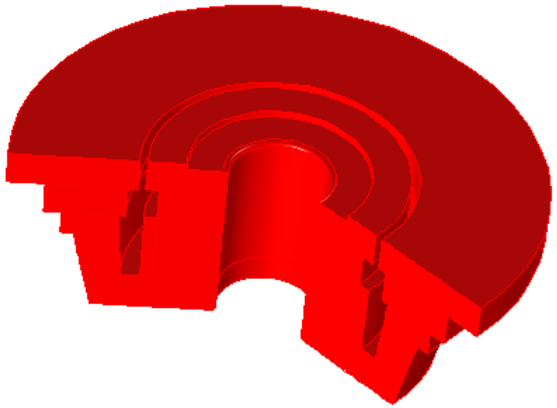


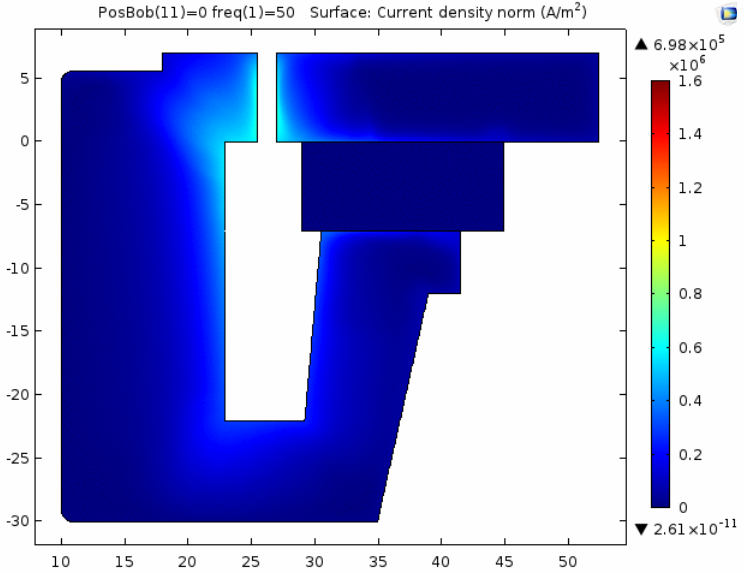
Electromagnetism:
designing the magnet assembly and voice coil

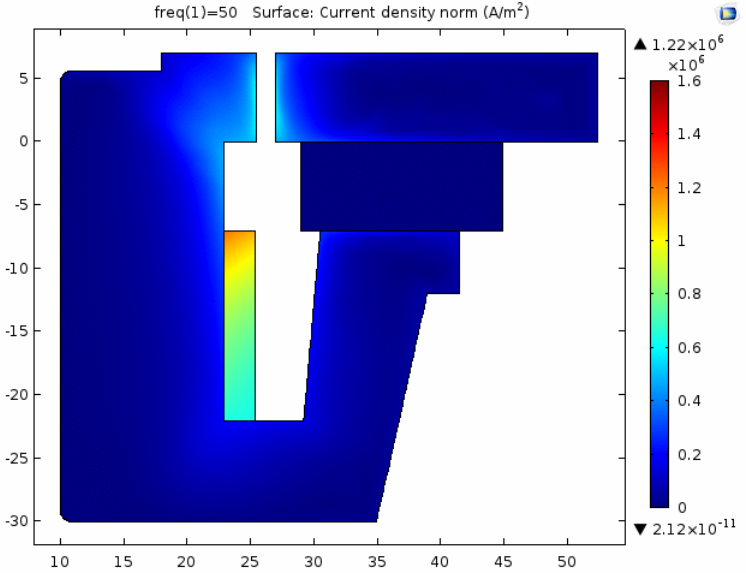




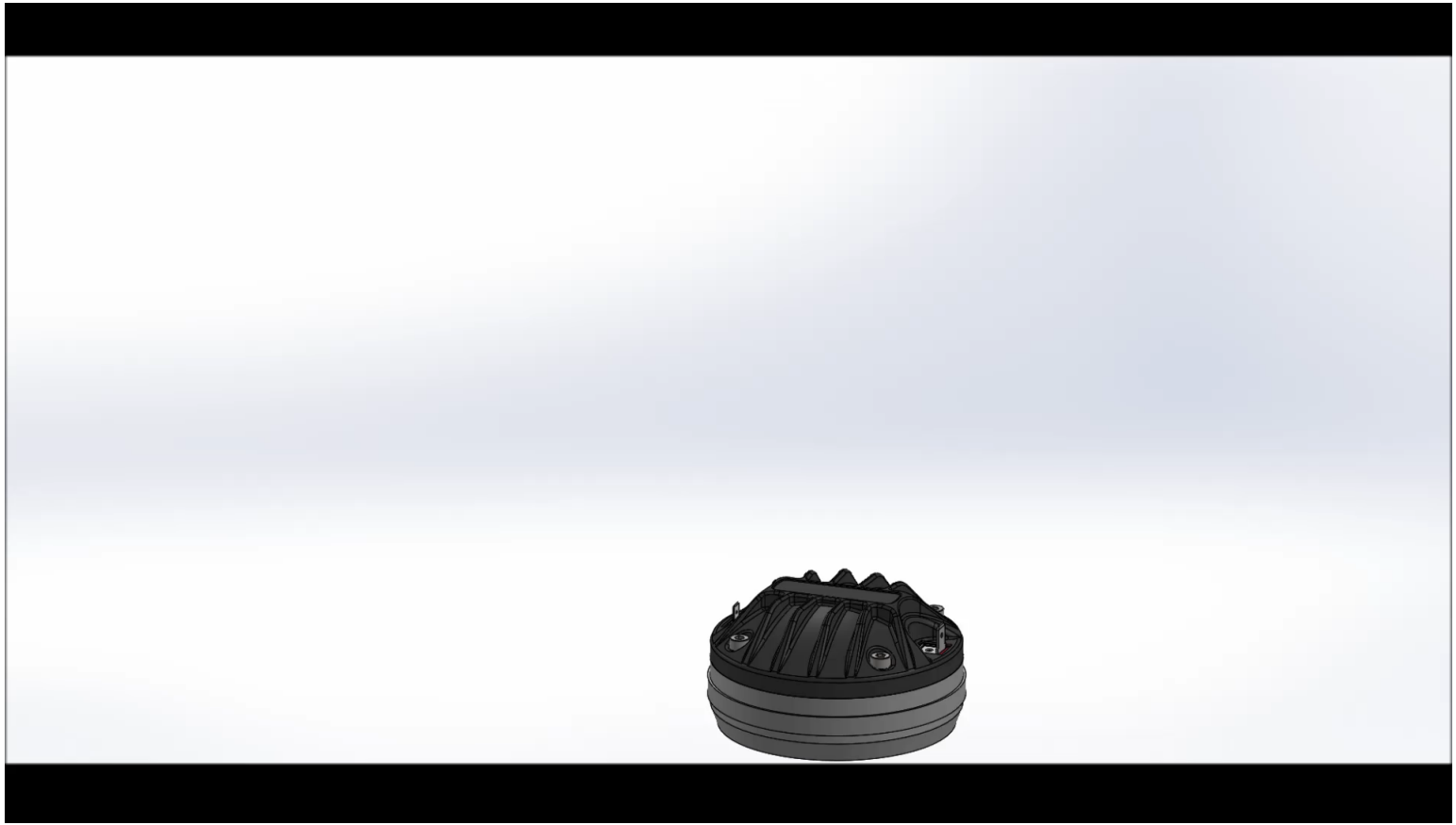
Electromagnetism: eddy currents



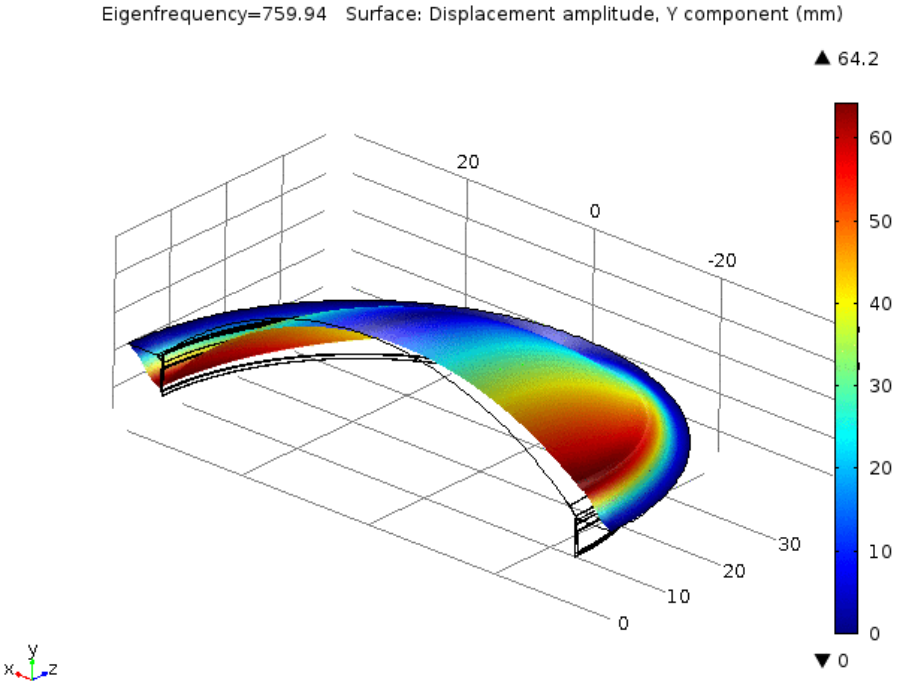


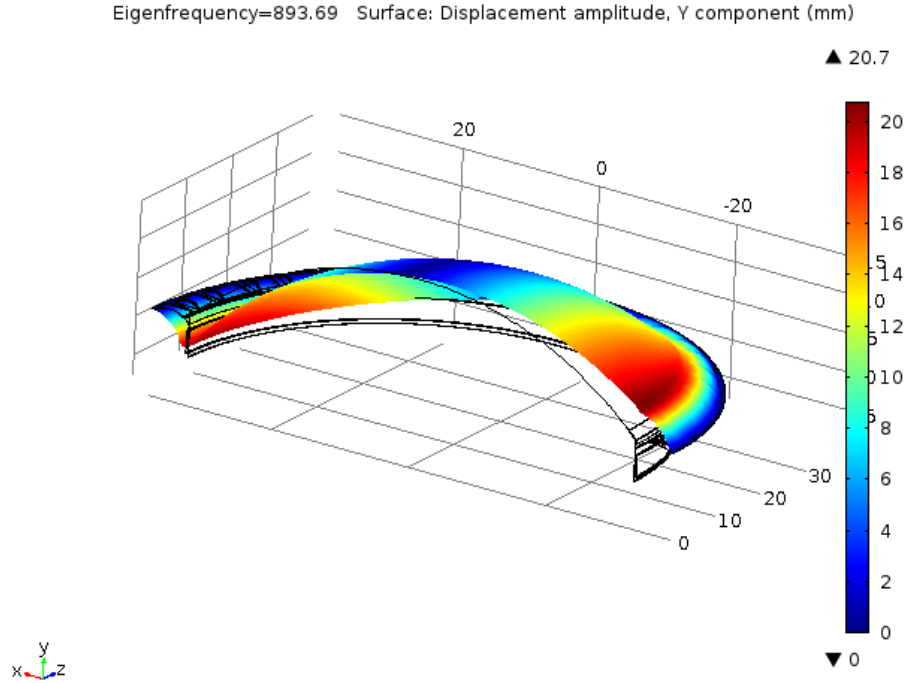


Compression driver loudspeaker

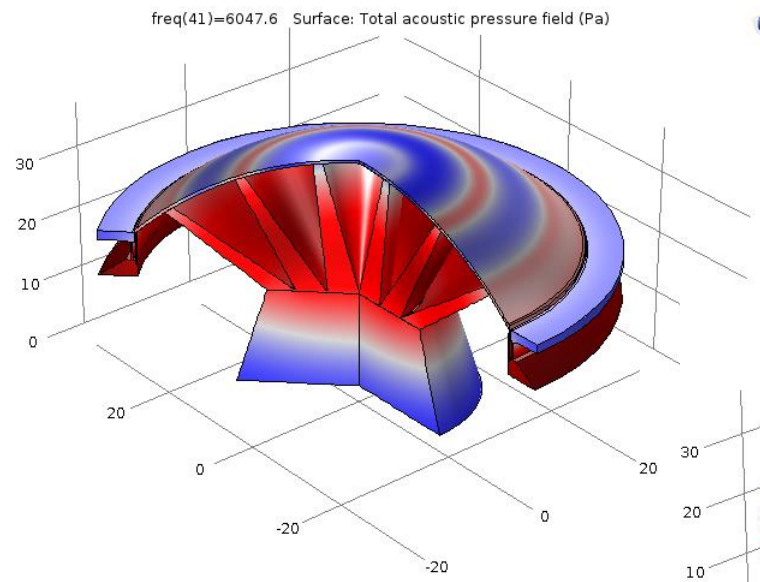


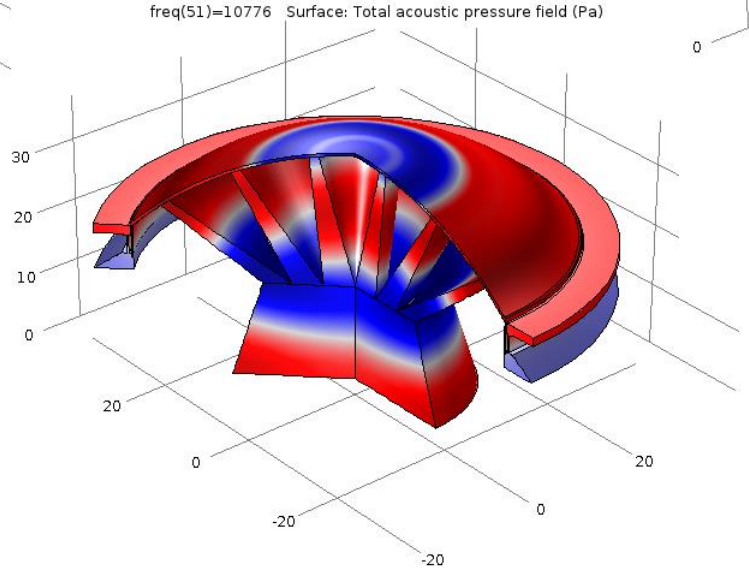
Mechanics:
compression driver moving assembly

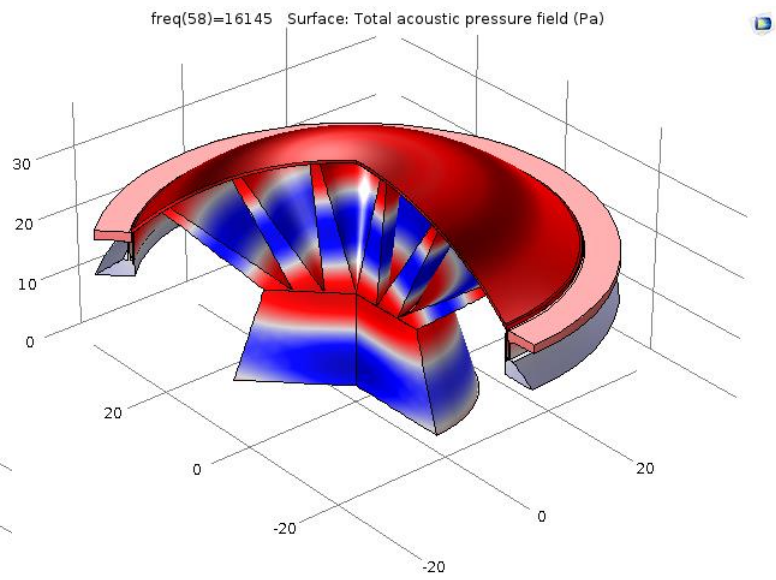




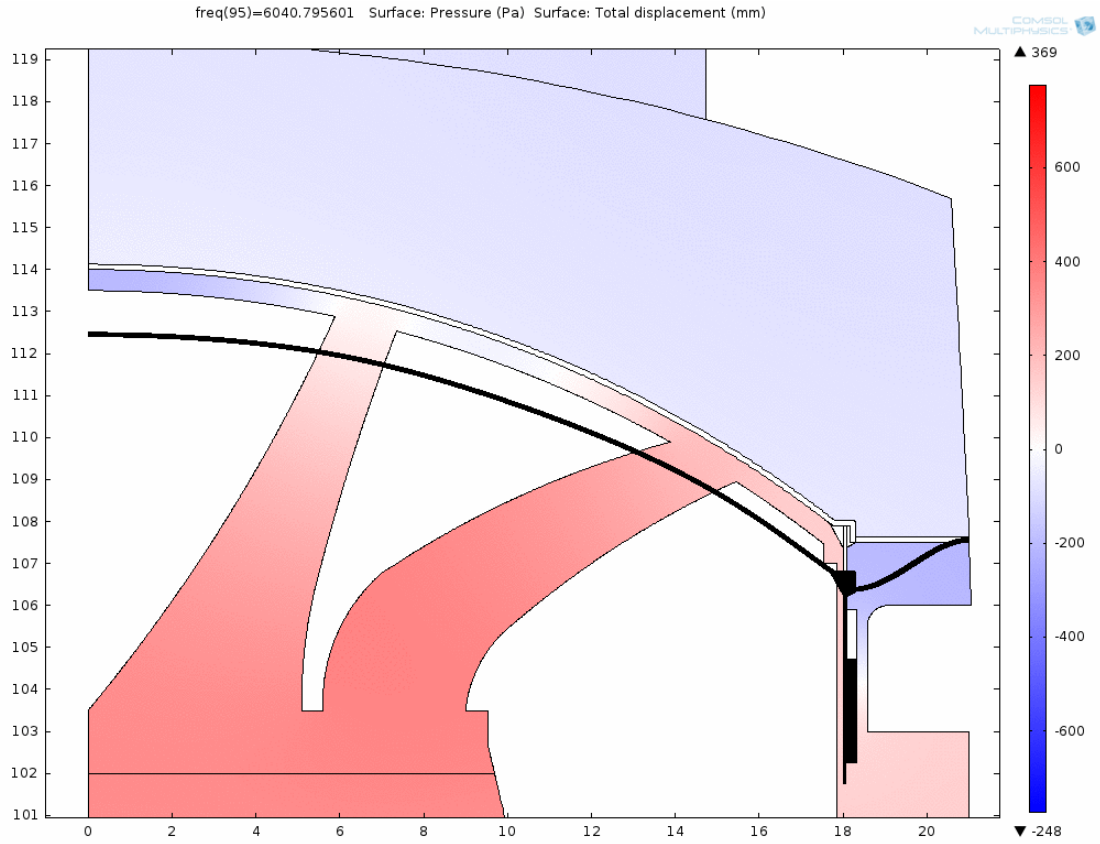
Acoustics:
phase plug design



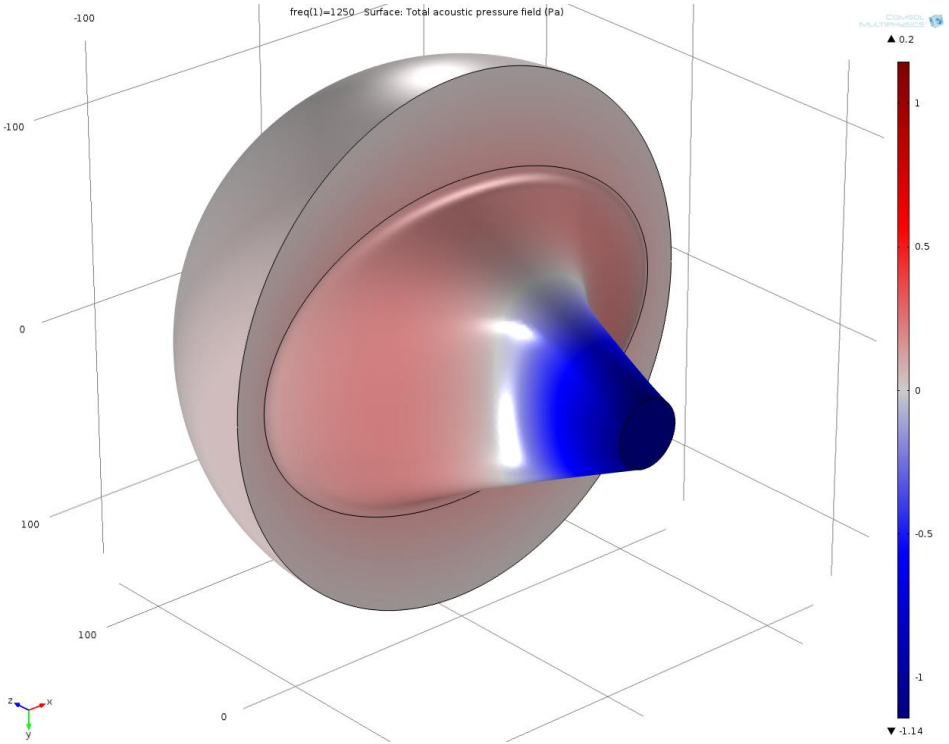


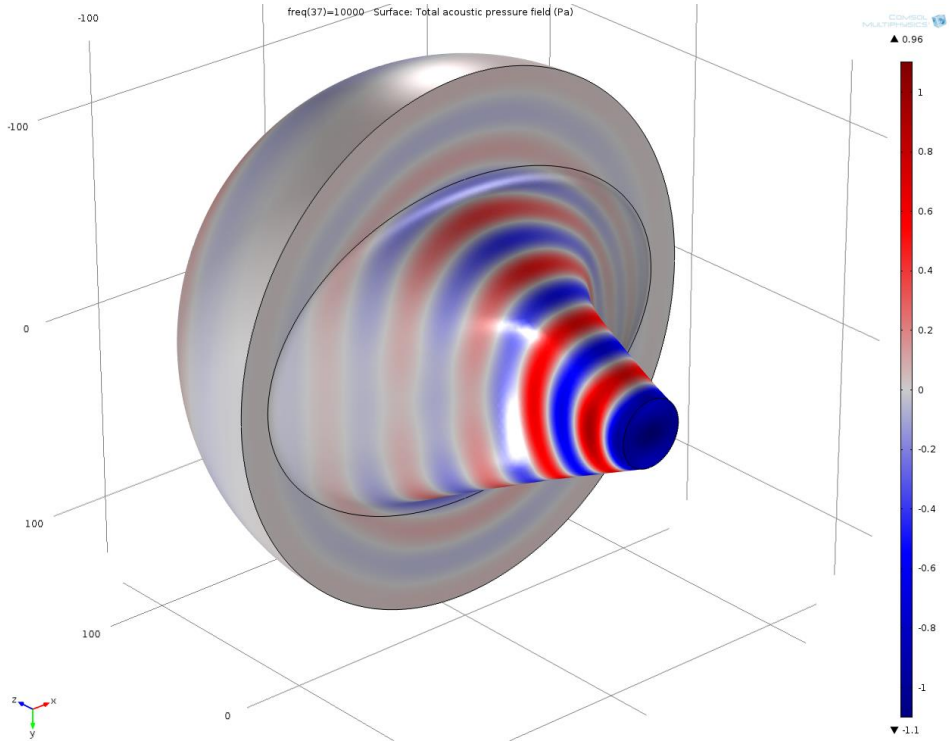


Mechanics + Acoustics: compression driver interior

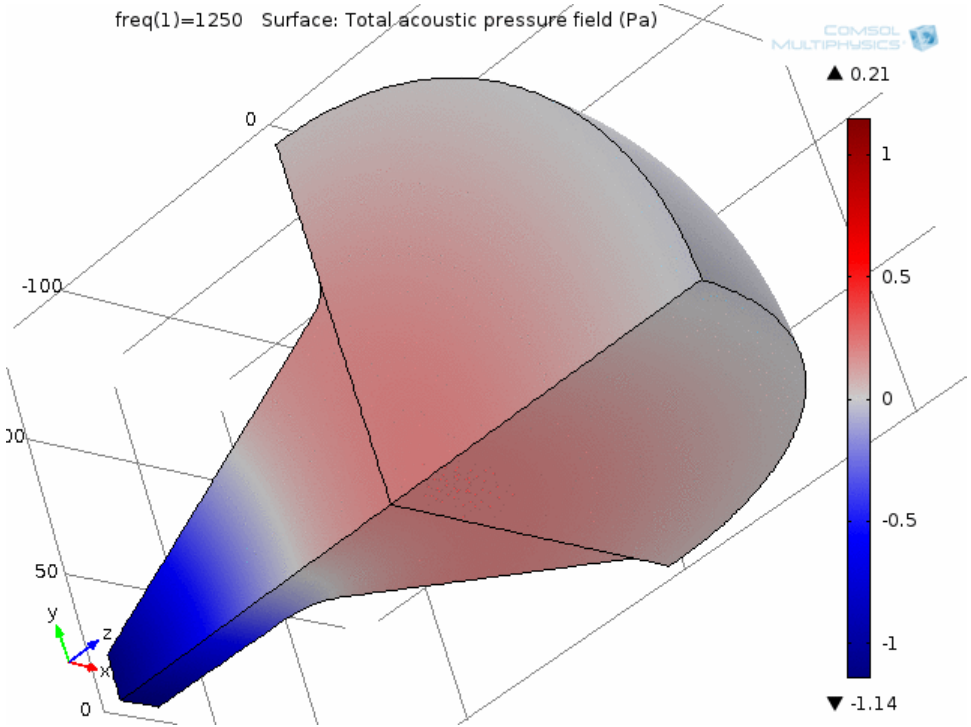


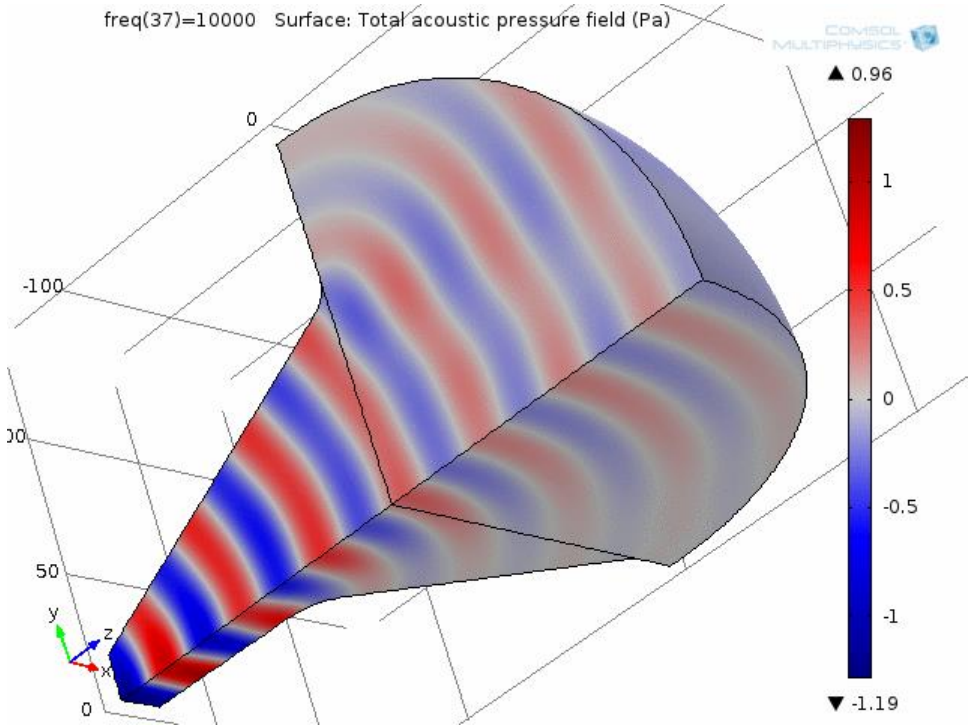
Acoustics:
loudspeaker horn



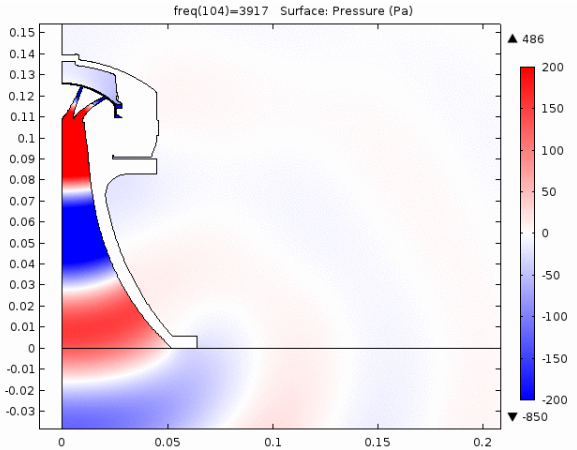


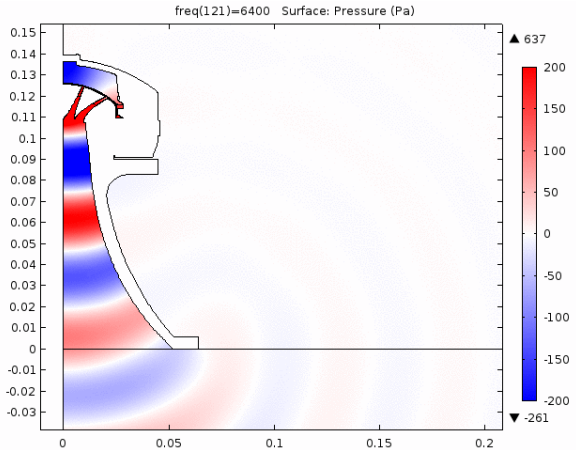
Acoustics:
loudspeaker horn

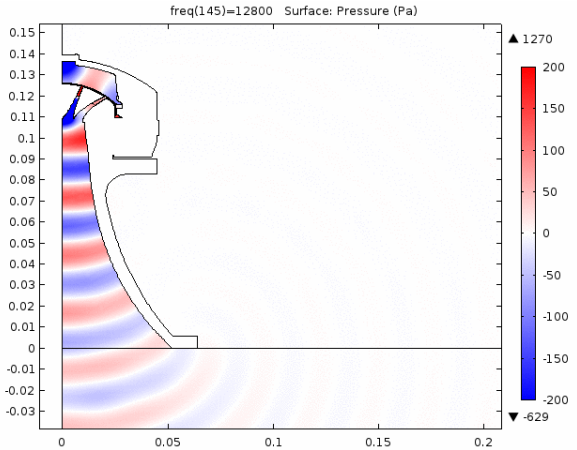




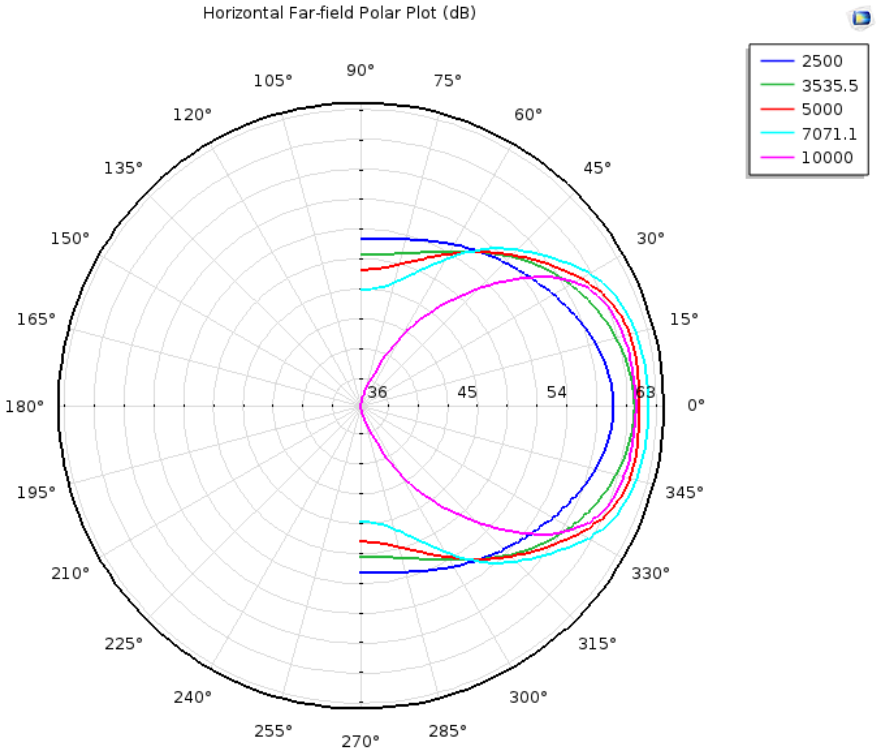
Mechanics + Acoustics: compression driver on horn

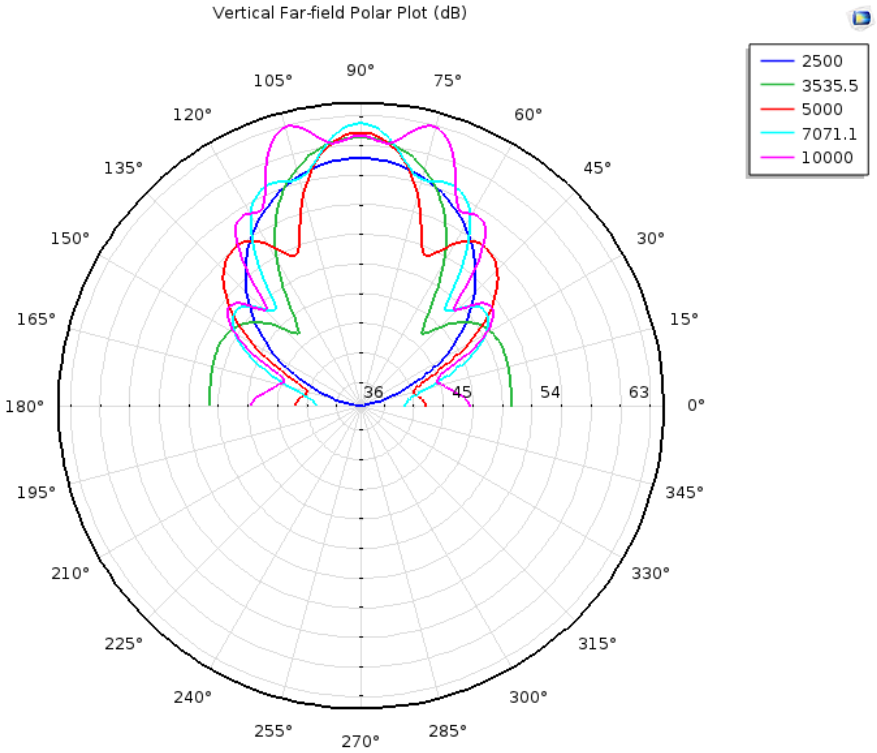




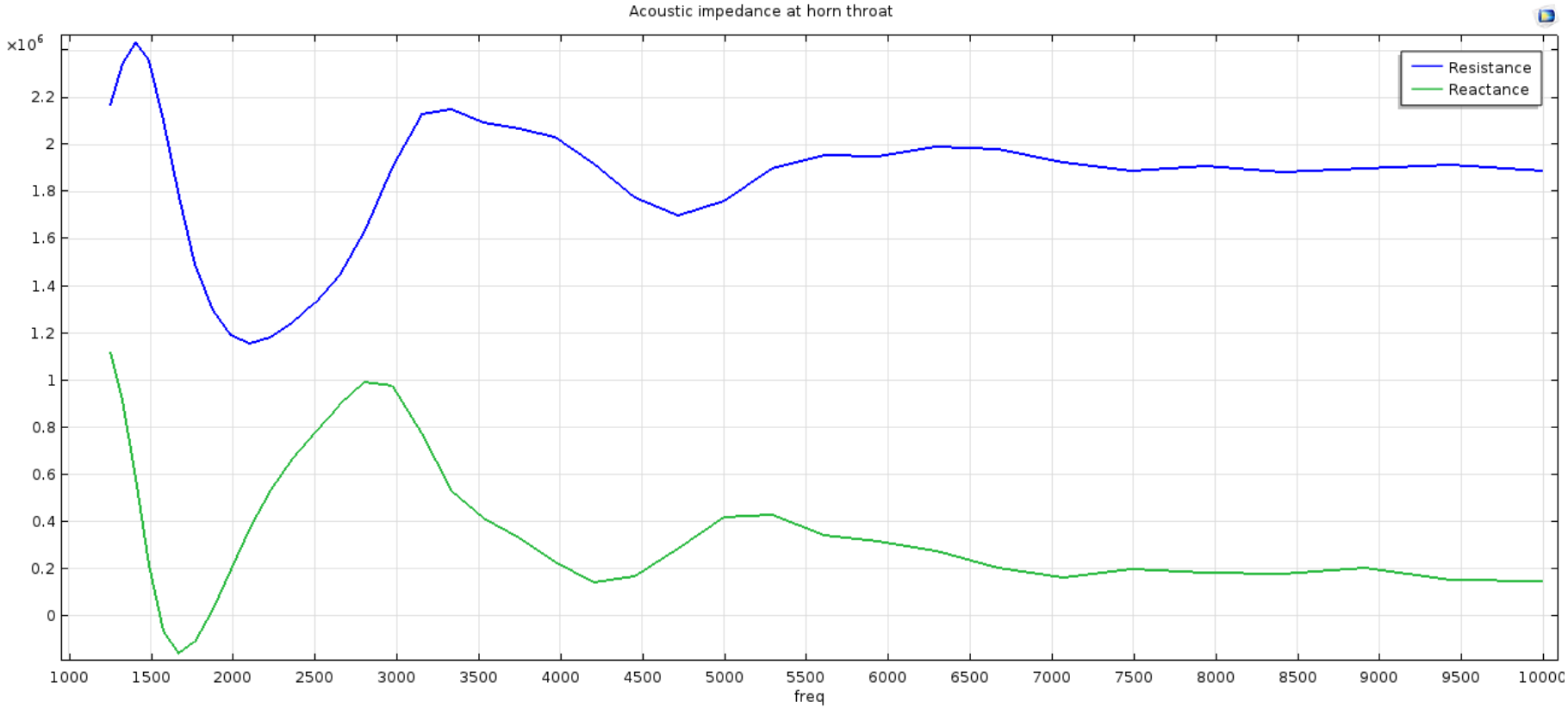


Acoustics:
radiation pattern of a horn

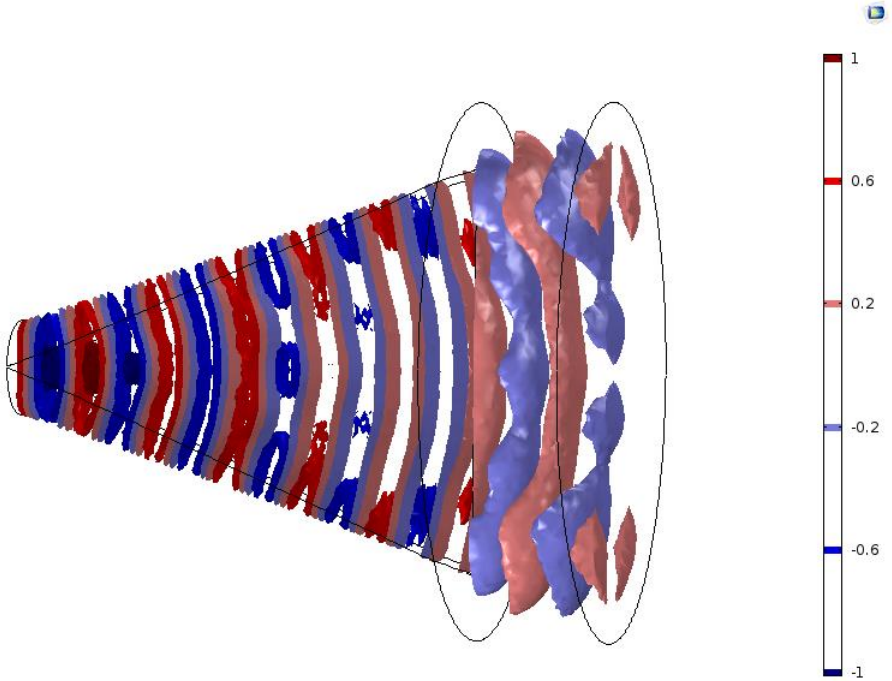


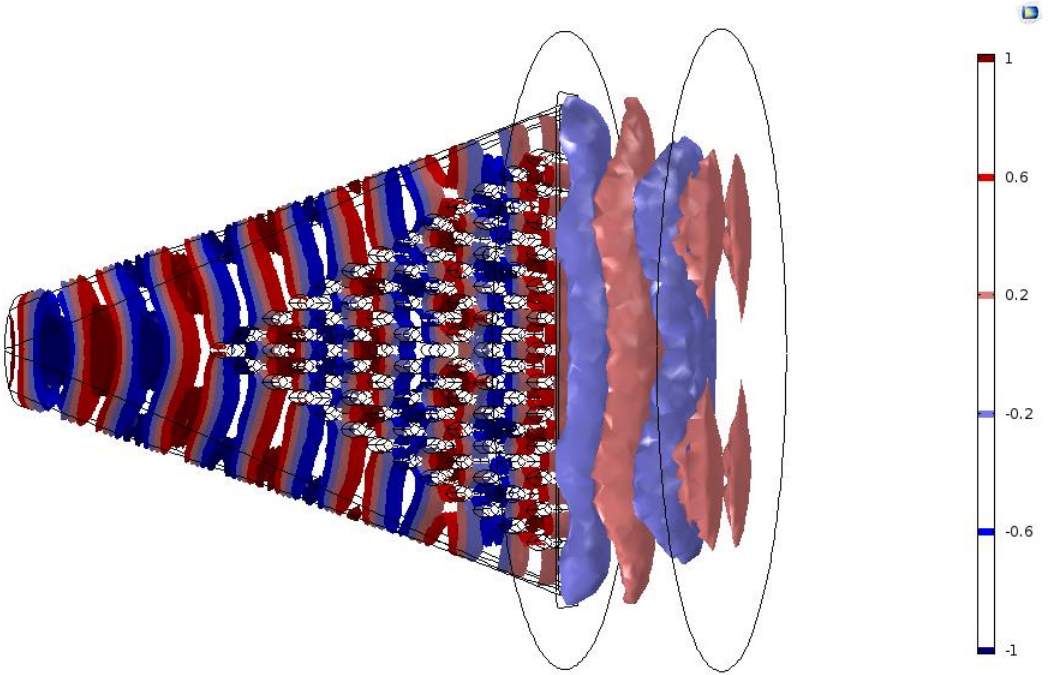


Acoustics:
acoustic load of a horn



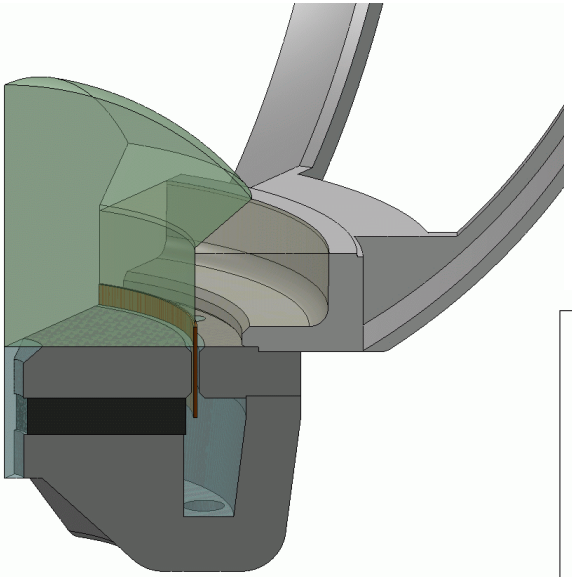
Acoustics:
wavefront shape in a line-array waveguide

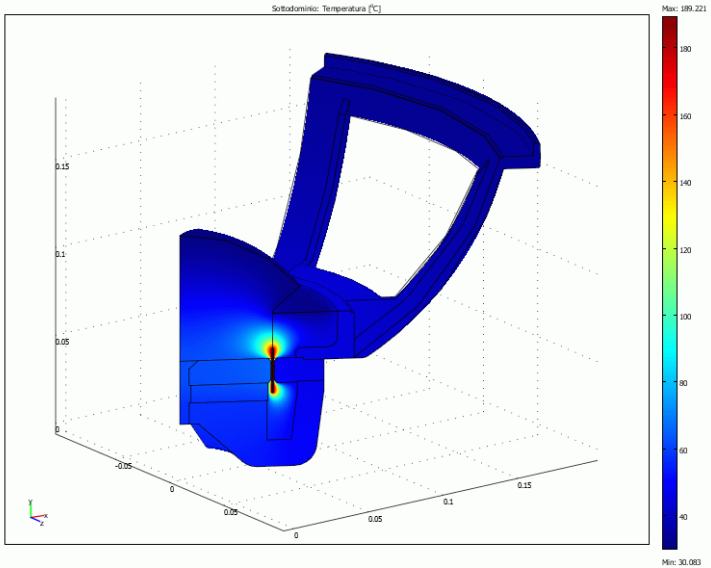


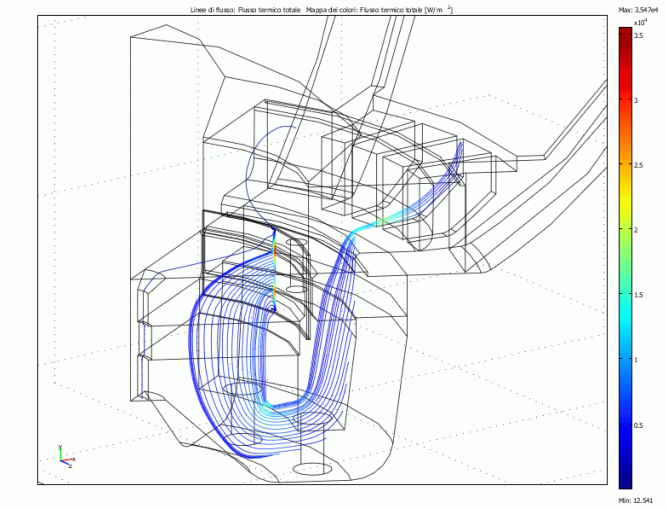


https://www.comsol.it/paper/optimization-of-an-acoustic-waveguide-for-professional-audio-applications-6771

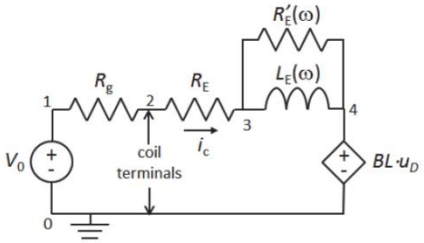
Thermodynamics:
heat paths through a loudspeaker

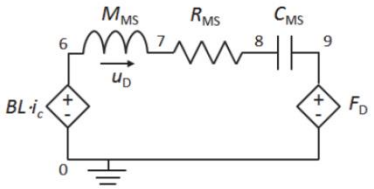


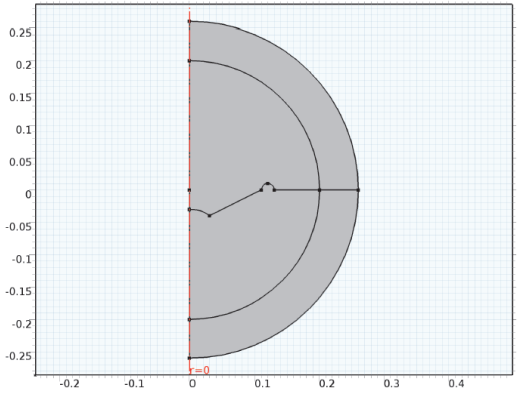




Lumped parameters models: Equivalent circuits







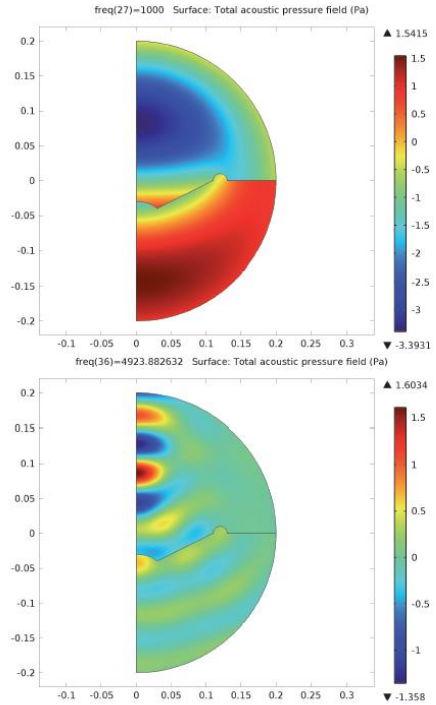
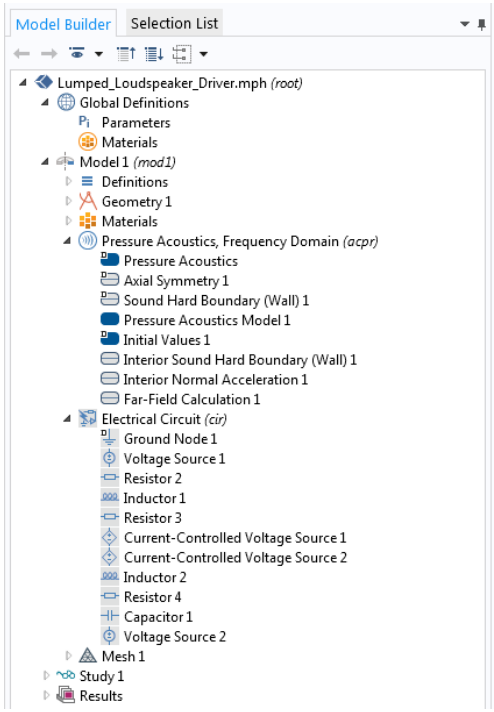
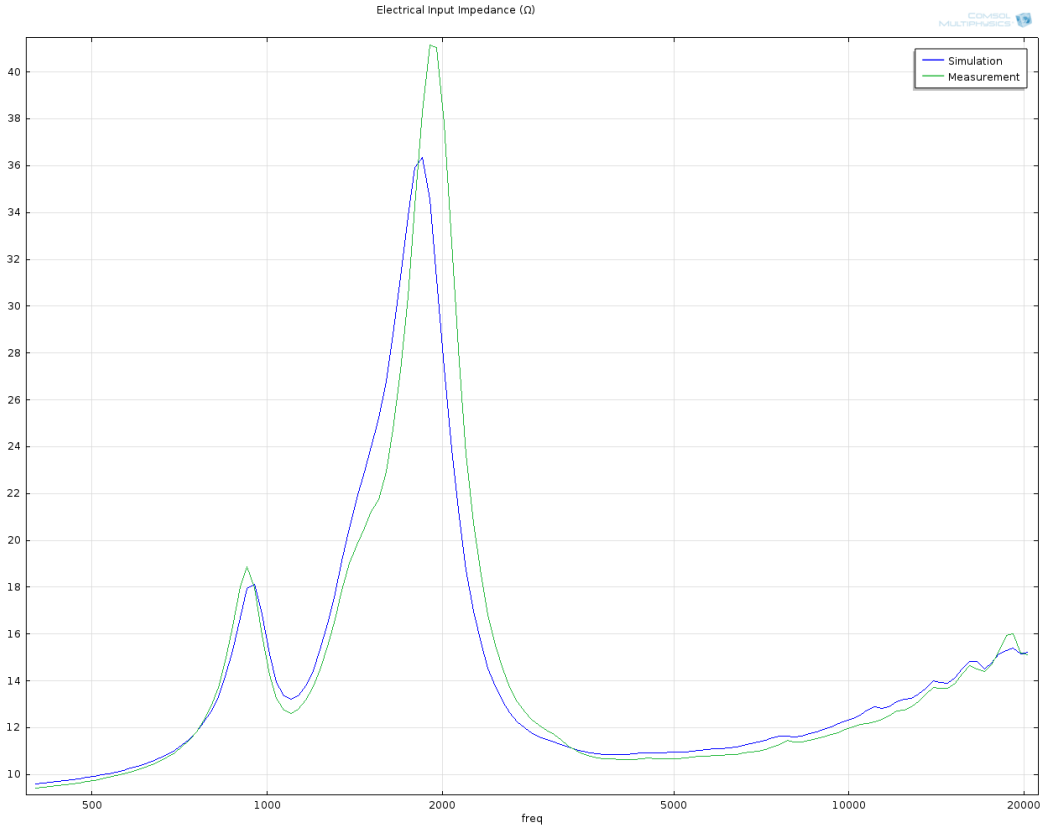


Figure 4: Acoustic pressure for a frequency of 1000 Hz (top) and 5000 Hz (bottom).

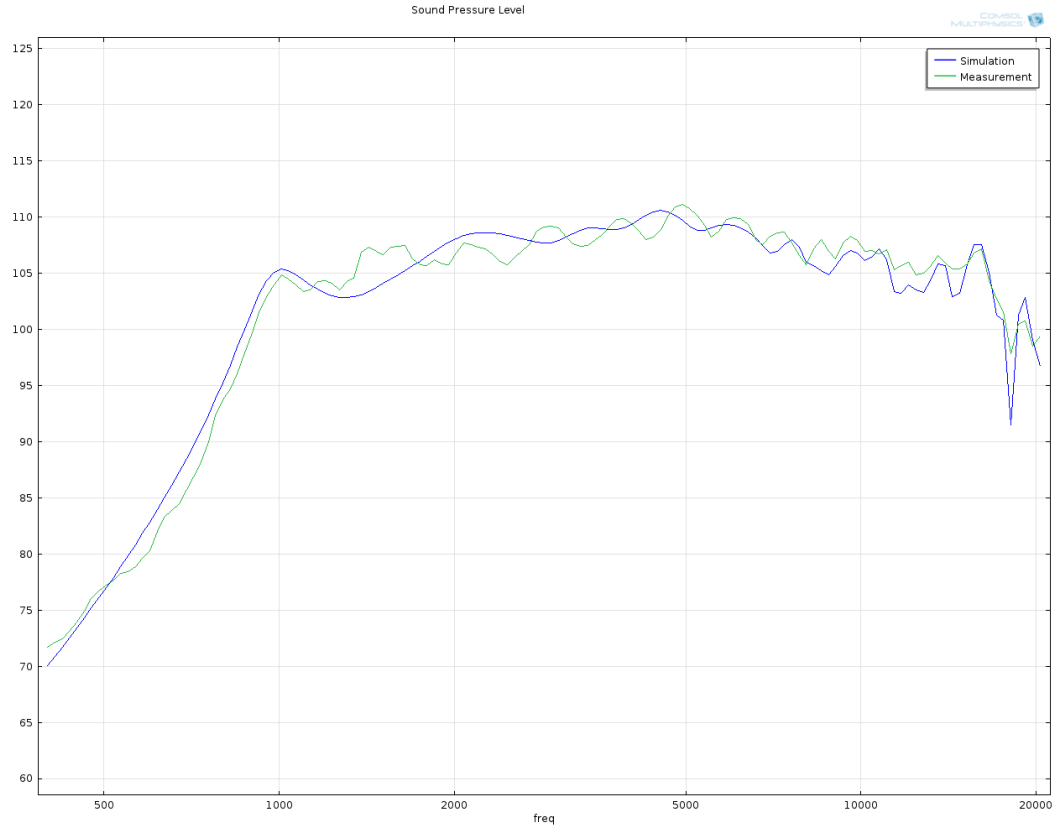


http://www.comsol.it/model/12295

Results: electrical impedance



Results: frequency response



Conclusions

- **Why COMSOL?**
  - A multiphysics device requires a multiphysics approach
  - Perfectly Matched Layers + Far-Field ≥ BEM
  - Equivalent circuits (lumped parameters modeling)
  - Increasing capabilities in Acoustics: Thermoviscous losses, Ray tracing
  - Optimization
  - Support

Thank you!

Roberto Magalotti

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