

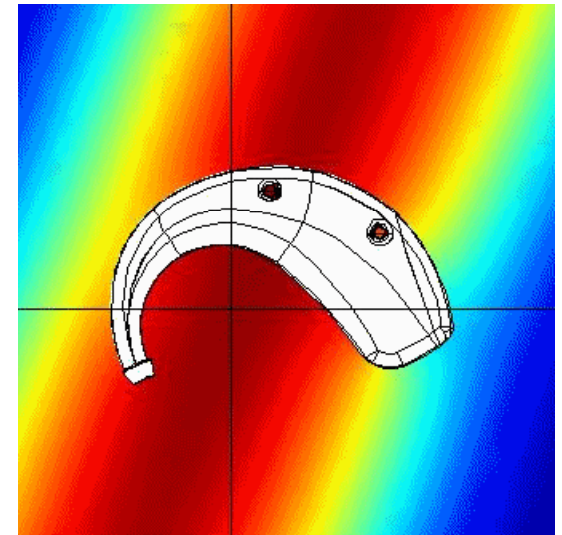
Improving the Performance of Hearing Aids Using Acoustic Simulations

Comsol conference, Milan, 2009

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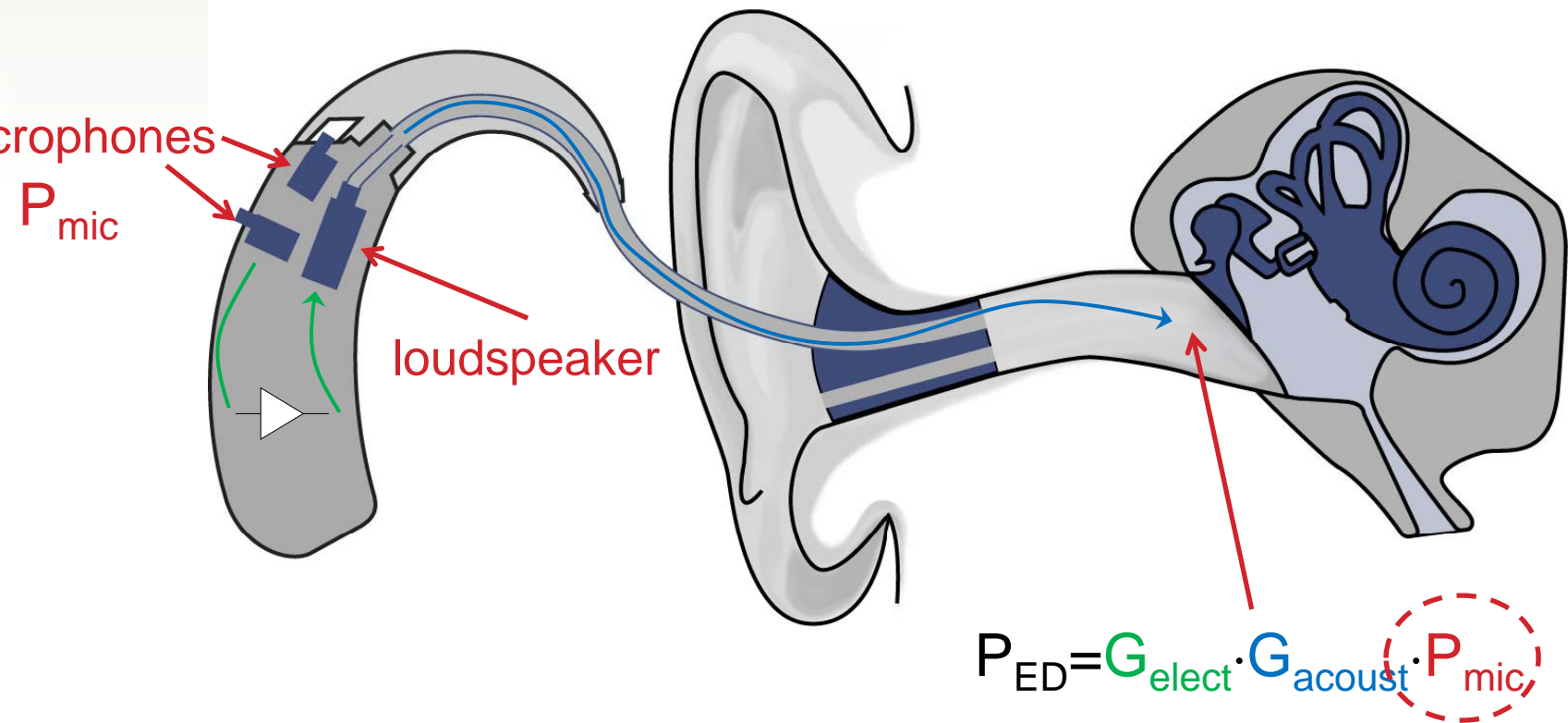
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$$\text{Re}(Pe^{i\omega t})$$

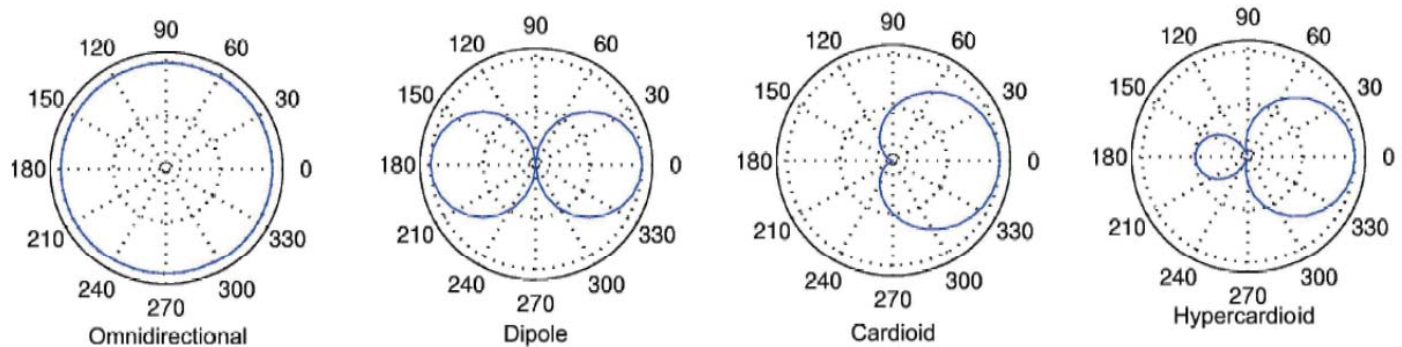
Introduction

What is a hearing aid?

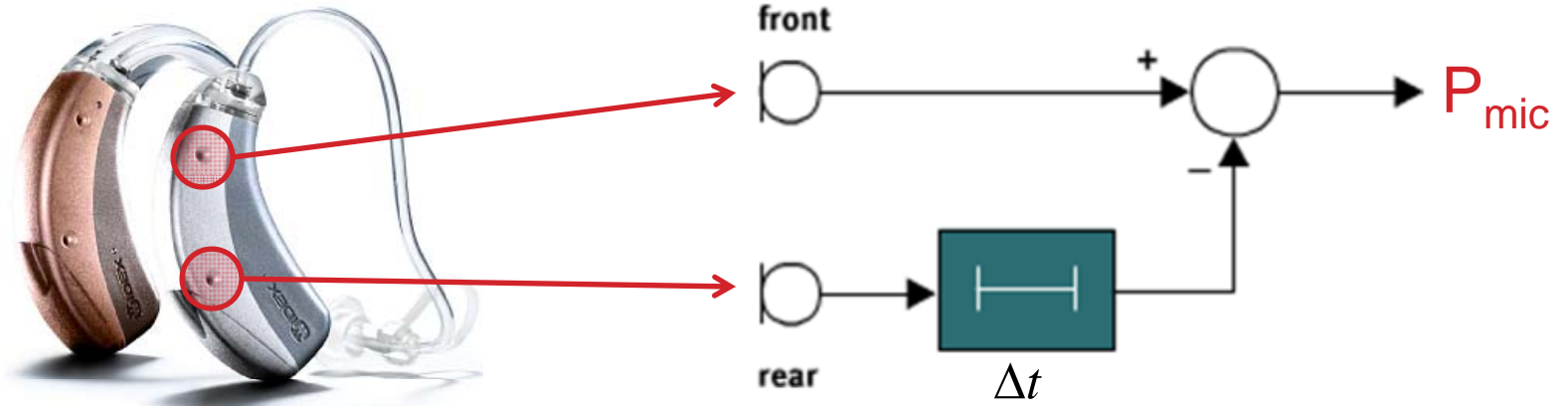


Directional microphones

- Spatial noise reduction



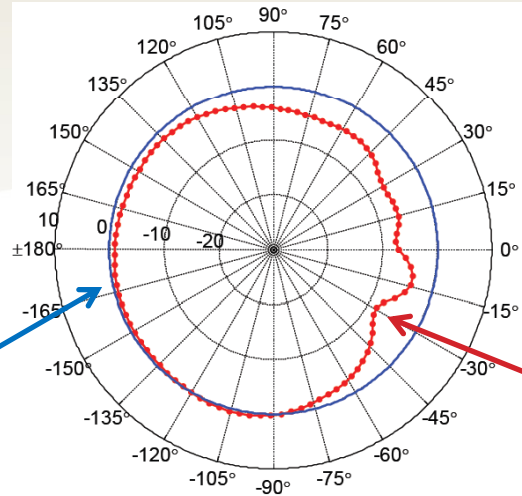
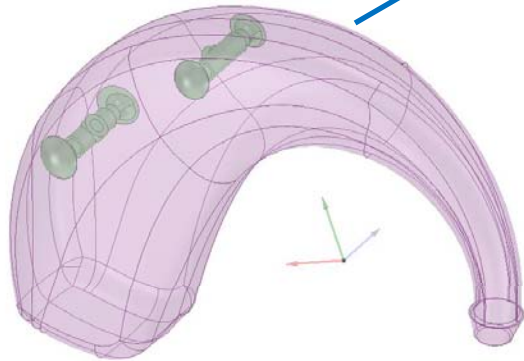
- Two microphone system (delay and subtract)



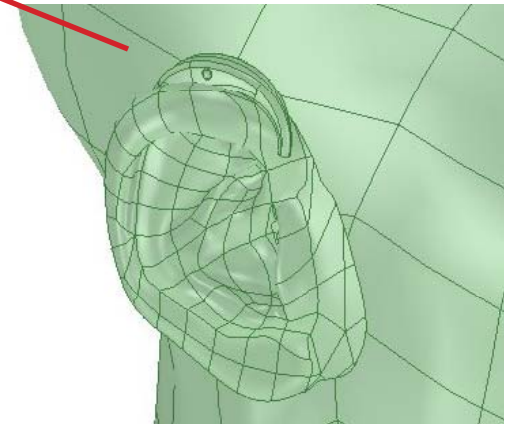
Motivation

What do we want to model?

ideal:
in free field

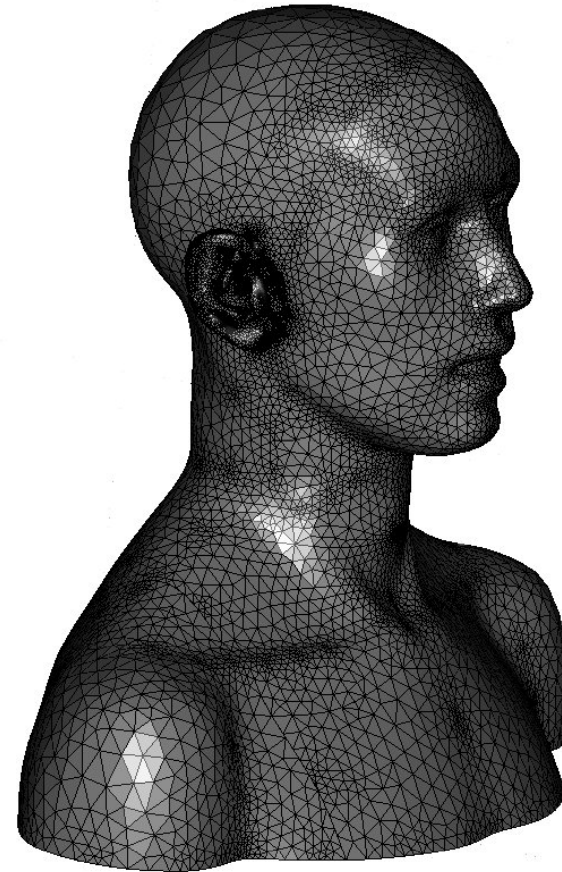
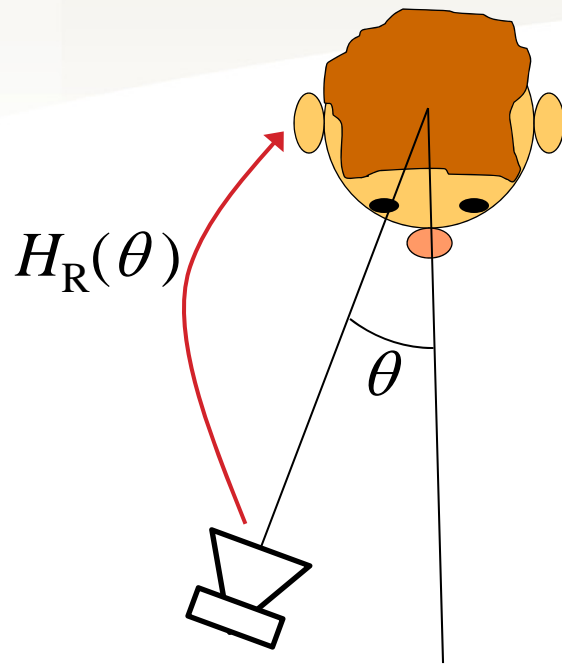


true:
on ear/head



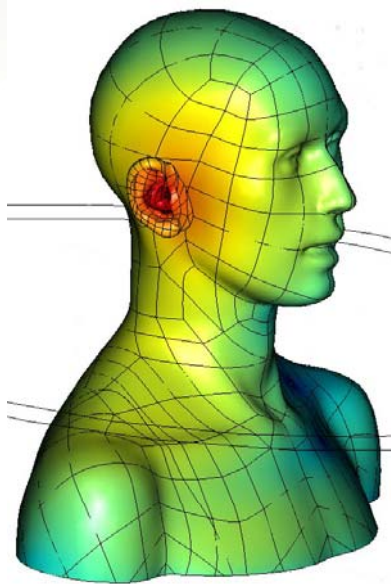
Directional pattern of head

- Verification of model with KEMAR mannequin

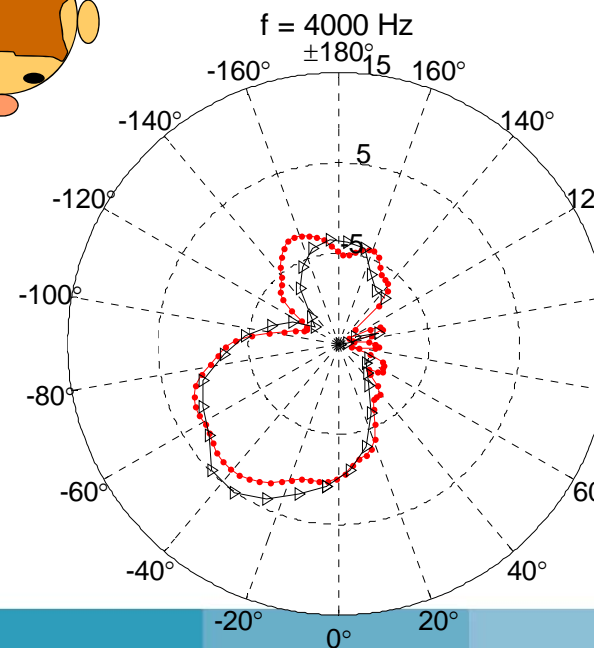
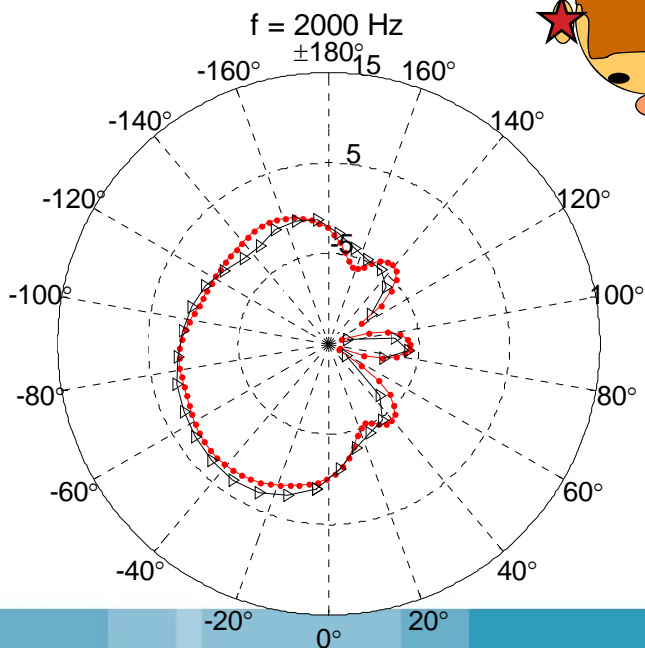
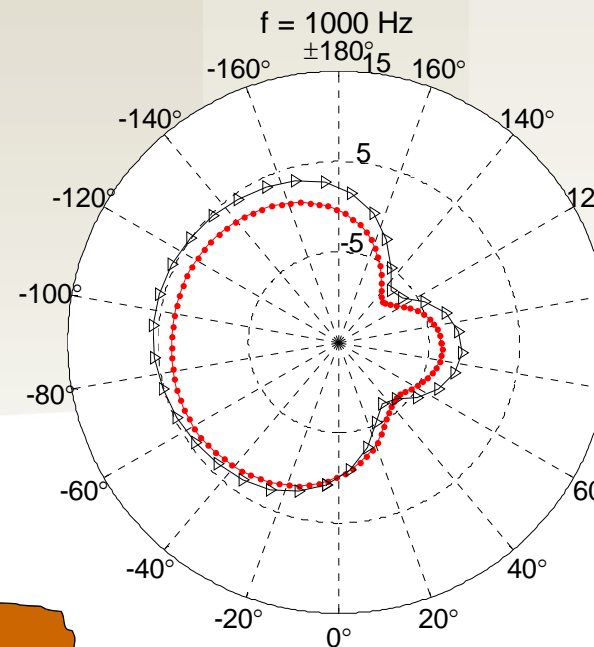
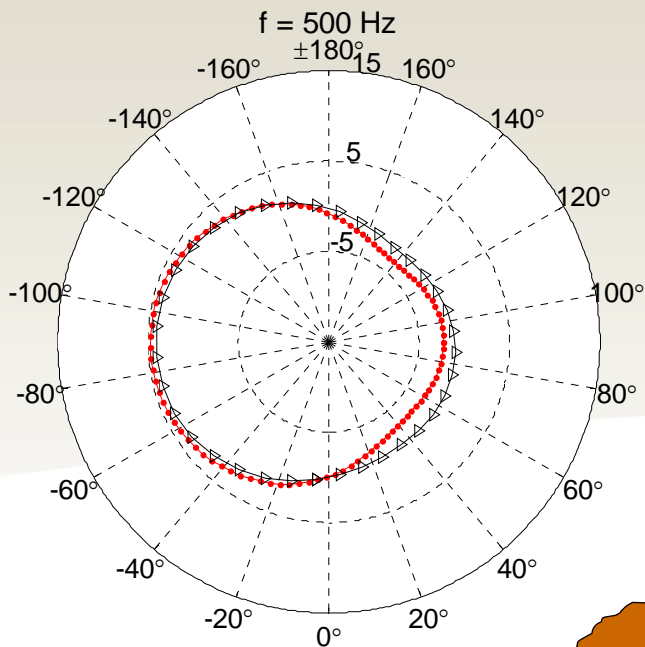


Results

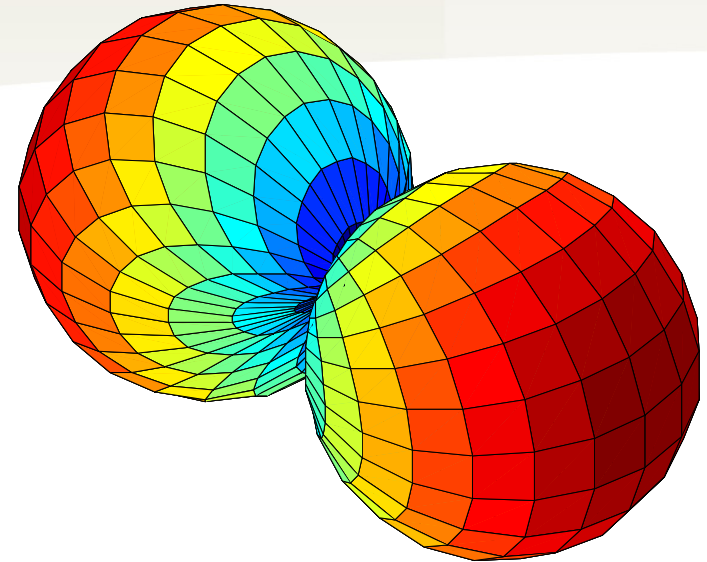
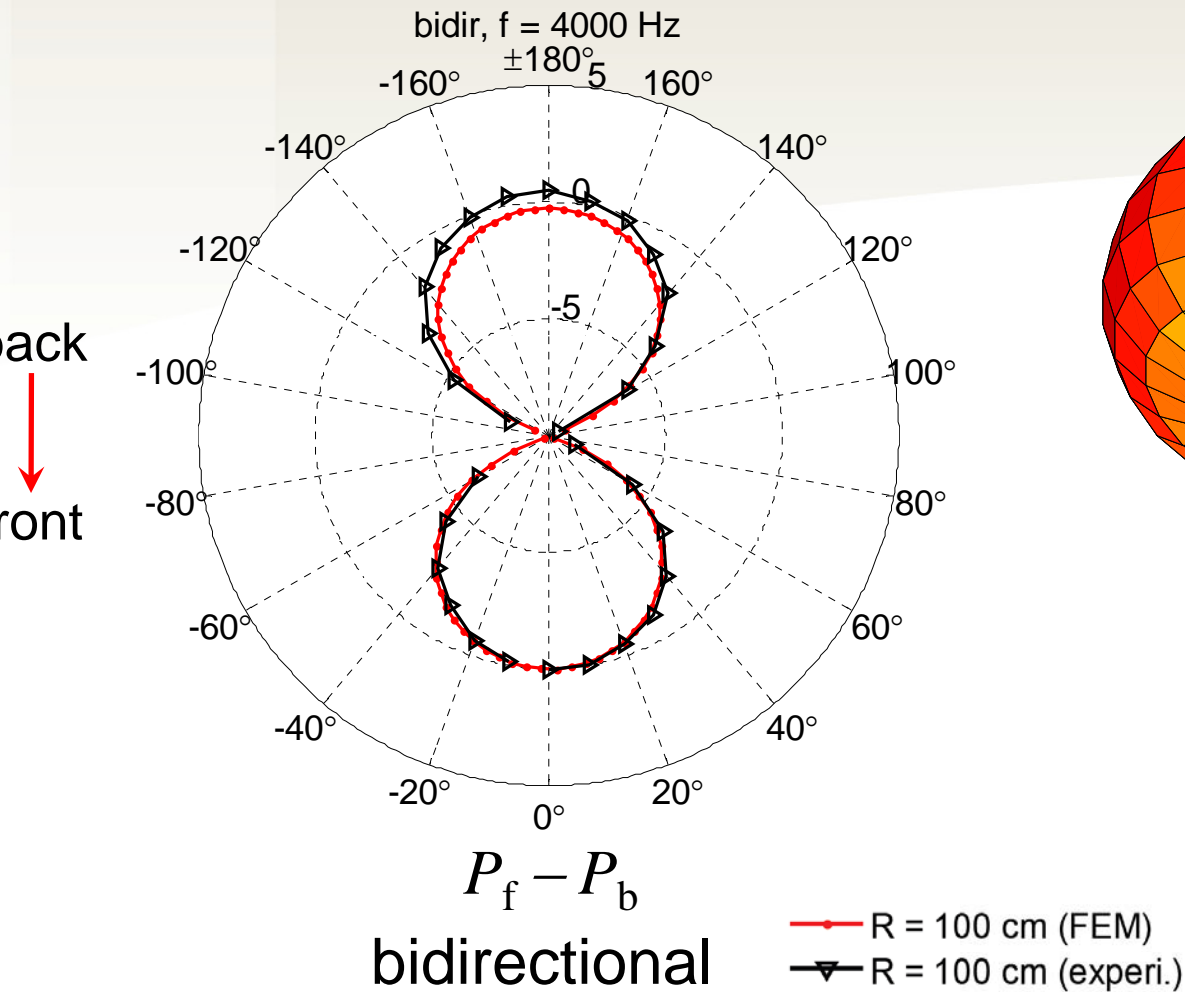
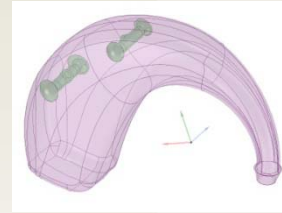
Directional pattern of head



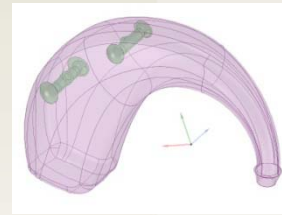
—●— R = 100 cm (FEM)
—▼— R = 100 cm (experi.)



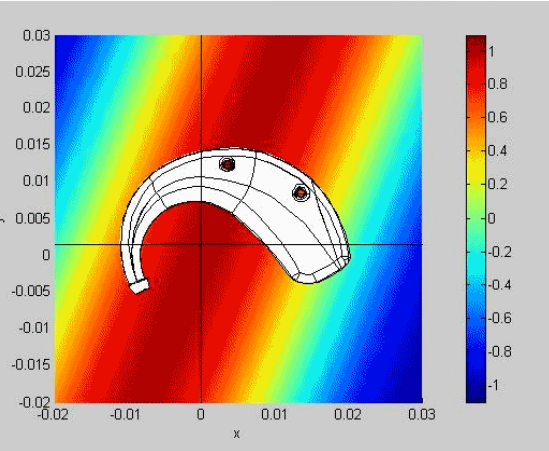
Hearing aid in free field



Hearing aid in free field

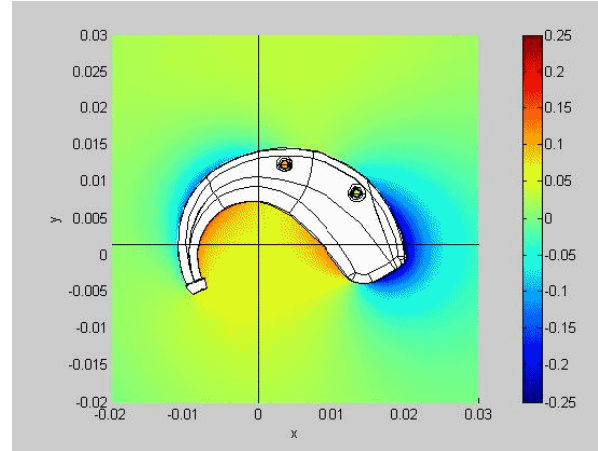


incoming



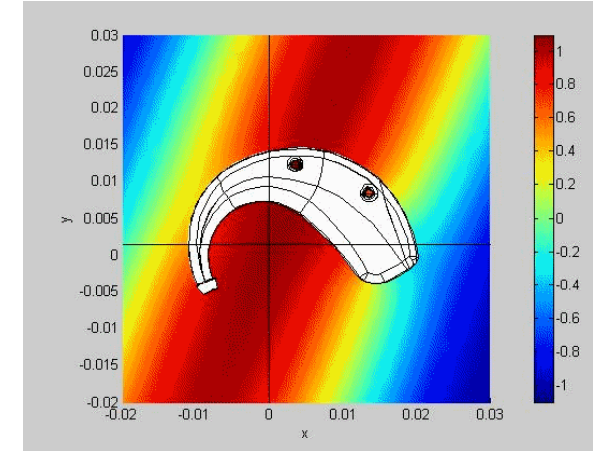
$$e^{ik \cdot x}$$

scattered



$$P_s$$

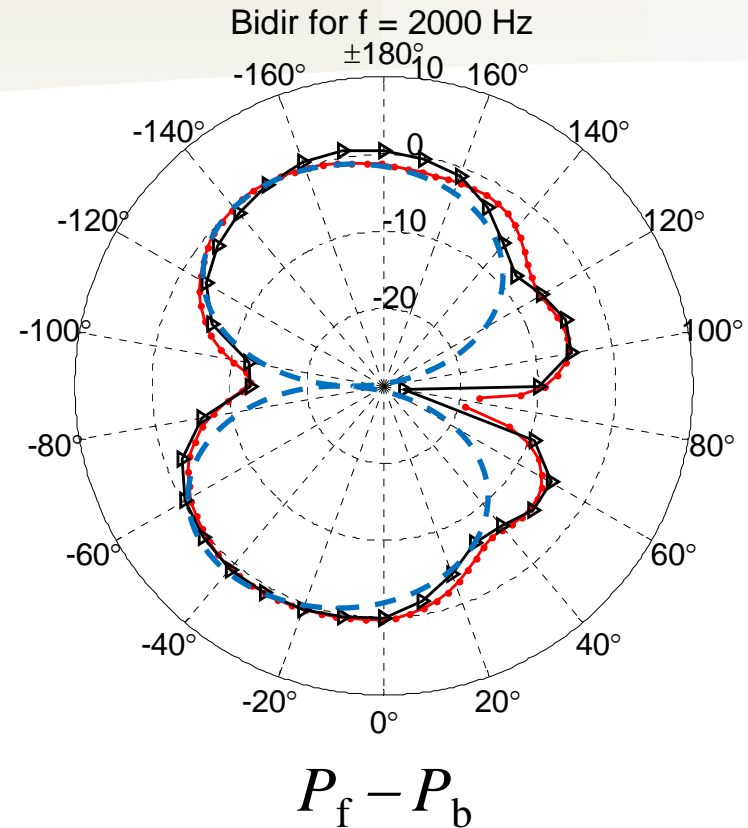
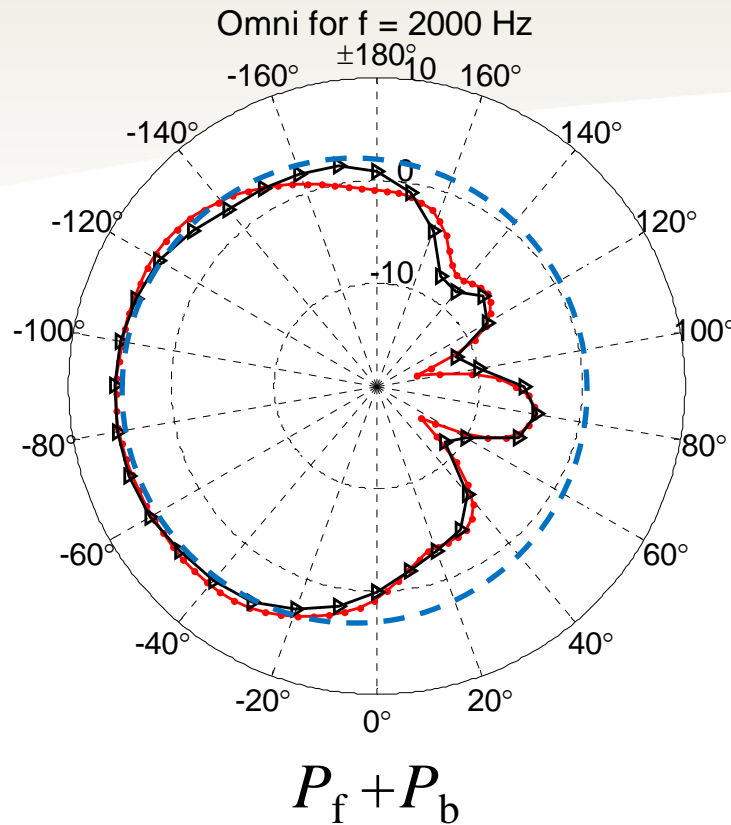
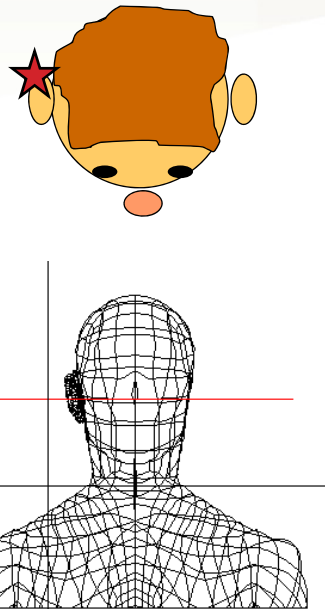
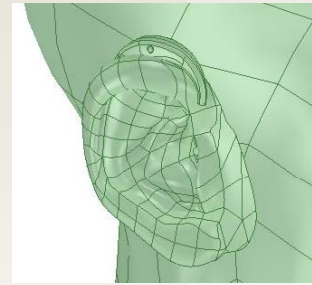
total



$$P$$

$$f = 5000 \text{ Hz}$$

Hearing aid on KEMAR



- R = 100 cm (FEM)
- - - R = 100 cm (experi.)

Conclusions

- Developed a tool for simulating directional characteristics of hearing aids in free field and when placed on a head.
- Save a lot of time compared to lengthy and complicated measurements.
- Early benchmarking and characterization of new hearing aid designs.
- Study the influence of the head on the directional microphone system. Input for the DSP guys.

Thank you!