

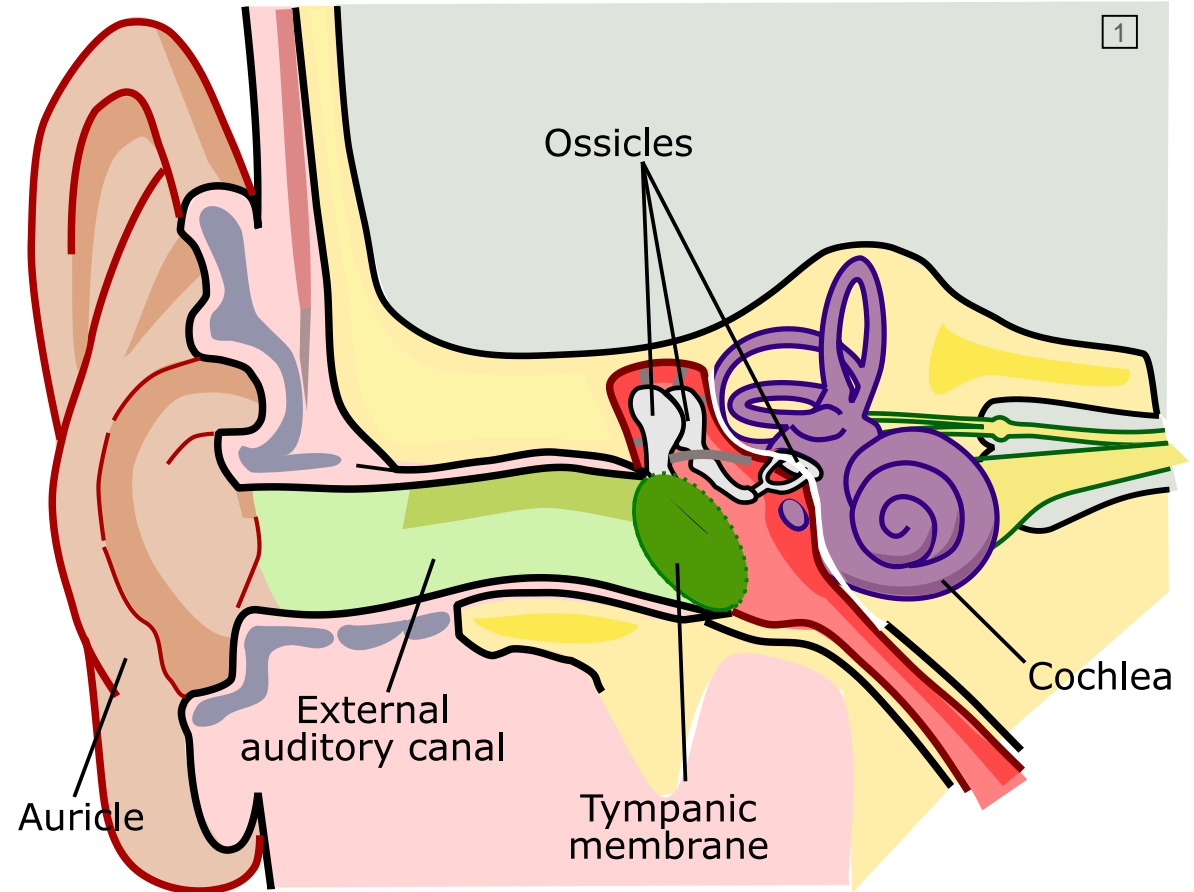
Validation of eardrum replacement scaffolds made from electrospinning

Dresden, 13.09.2019, Philipp Kempert



Introduction

- Myringoplasty (replacement of the tympanic membrane)
- Autologous material with unknown properties -> much experience of the surgeon is necessary
- Aim:
 - Identified material parameters
 - Identified oscillation of the reconstructed eardrum
 - Easier replacement



¹Lars Chittka; Axel Brockmann - Perception Space—The Final Frontier, A PLoS Biology Vol. 3, No. 4, e137
doi:10.1371/journal.pbio.0030137

Electrospinning samples

- Poly ethylene oxide terephthalate (PEOT), polybutylene terephthalate (PBT)
- Young`s Modulus = 3.6 MPa
- Electrospinning base material and additive manufacturing
- Thickness base material $\approx 13 \mu\text{m}$
- Thickness of additive manufacturing $\approx 100 \mu\text{m}$



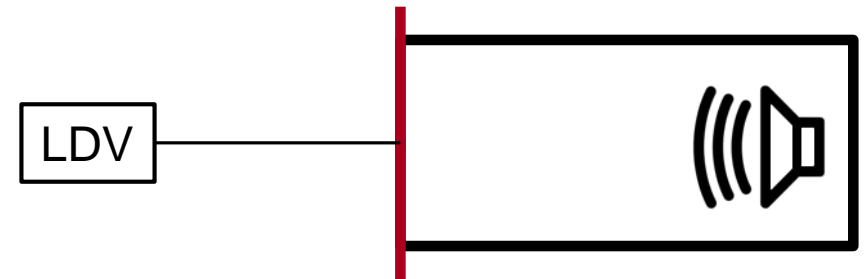
Base material



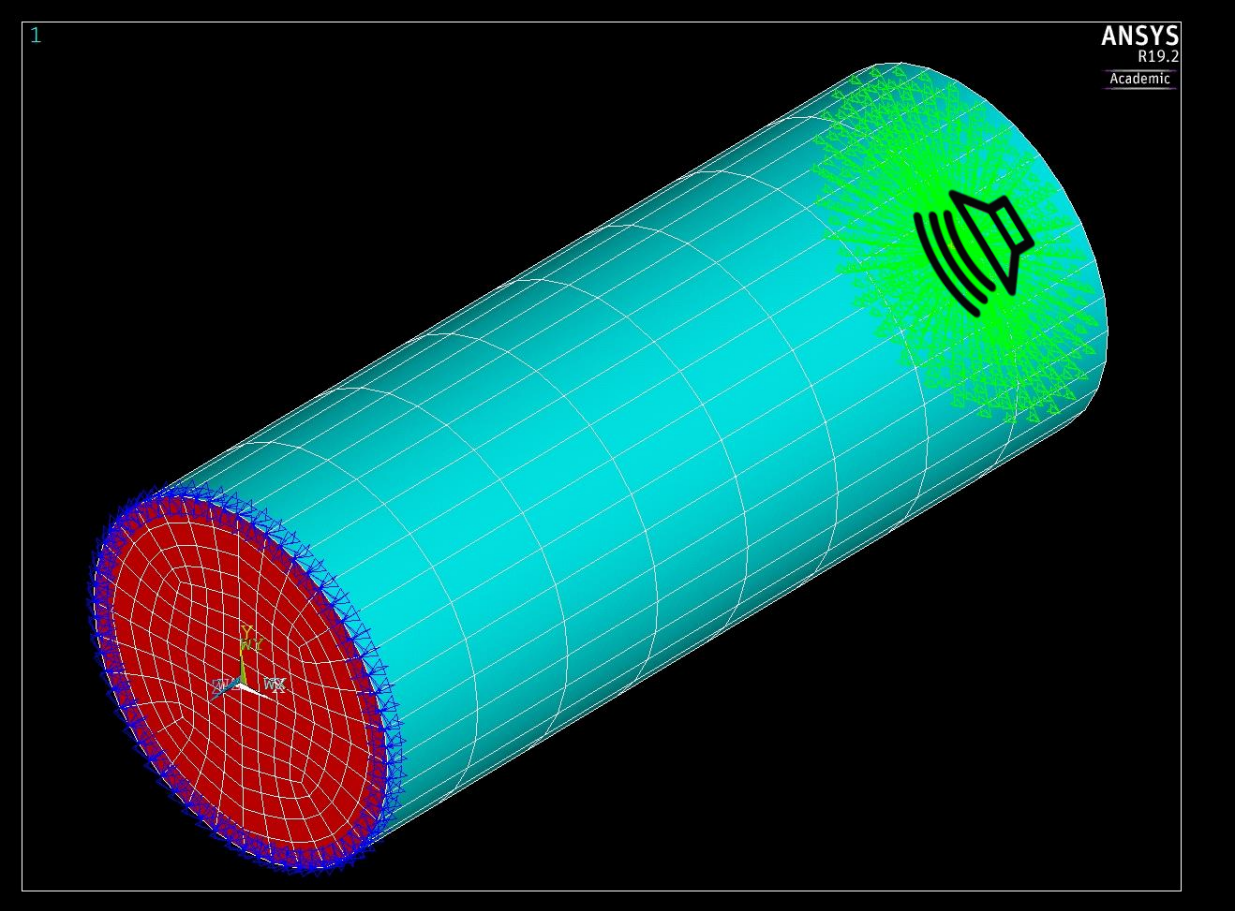
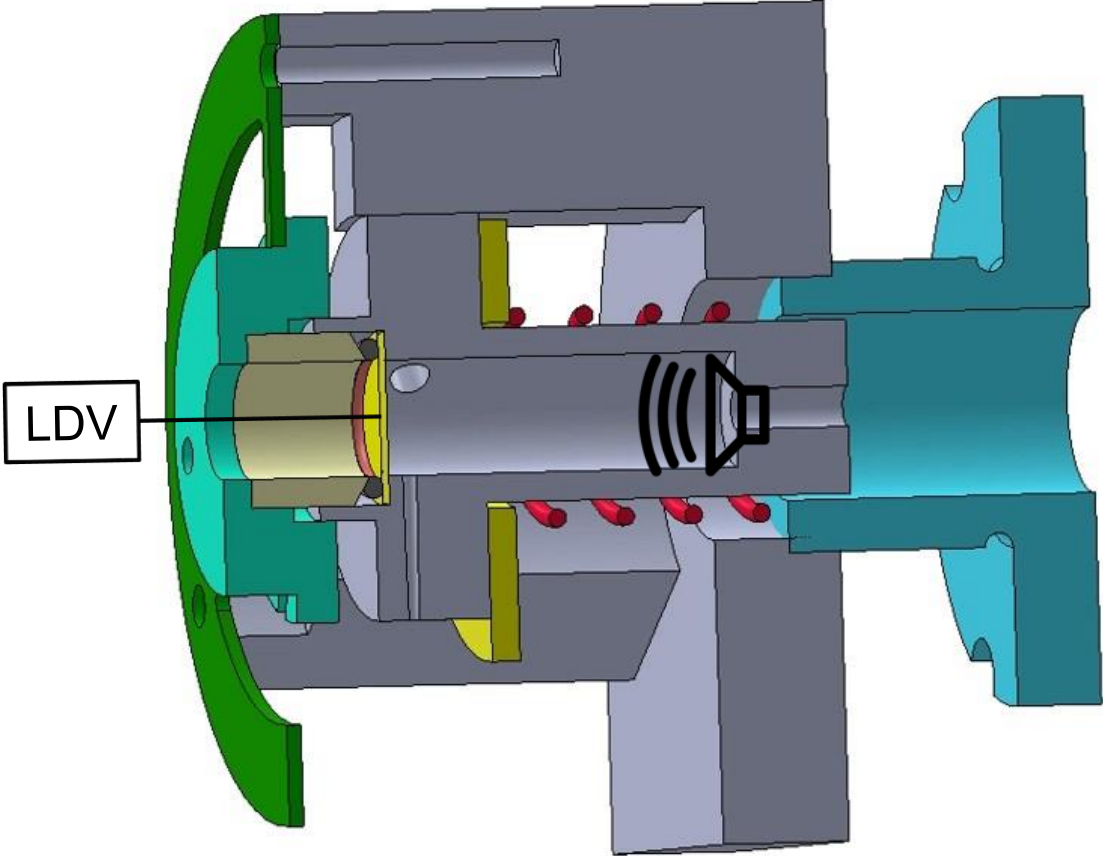
Base material with additive manufacturing

Methods

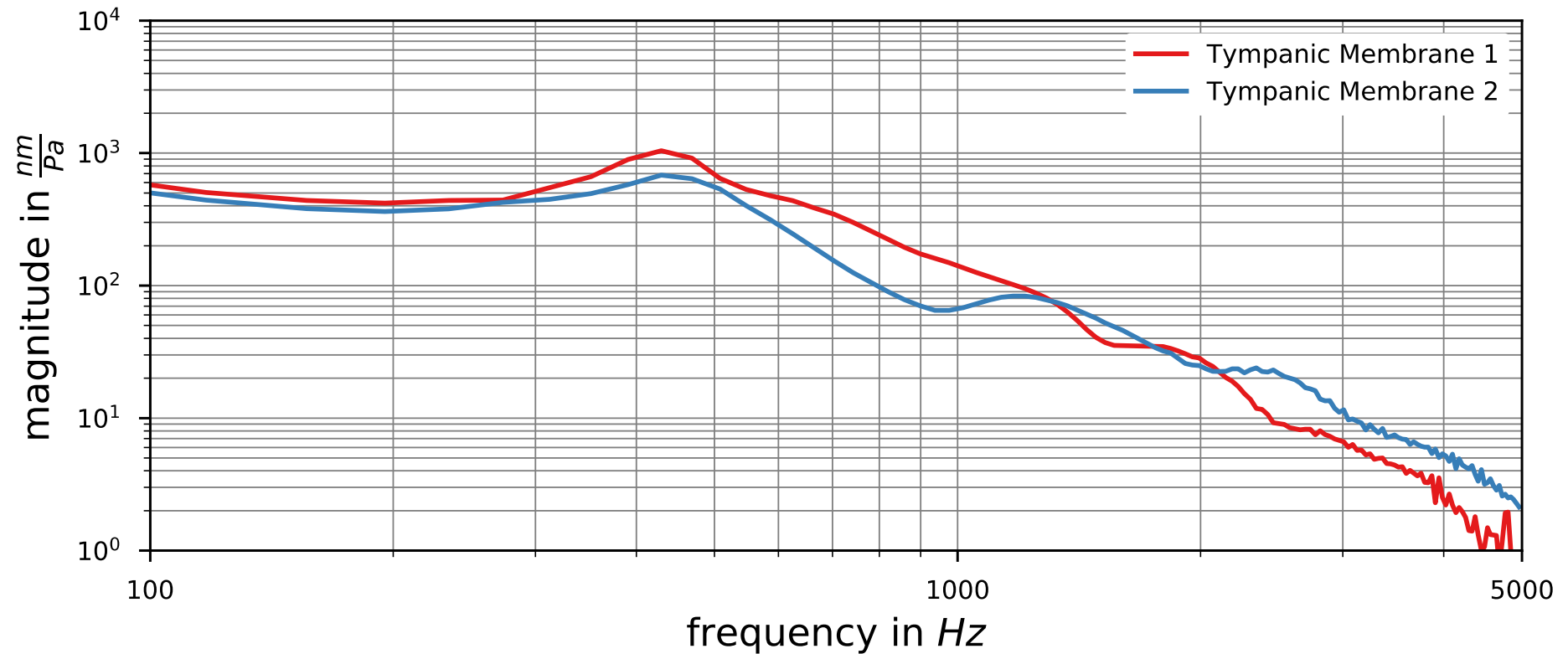
- Comparison of test stand and FE simulation model (Ansys)
- Applied sound pressure = 90 dB SPL $\approx 1 Pa$
- Applied quasi-static pressure = (1 to 4) kPa
- Measurement with a Laser-Doppler Vibrometer (LDV)
- Sample size diameter = 8 mm



Test stand and simulation model

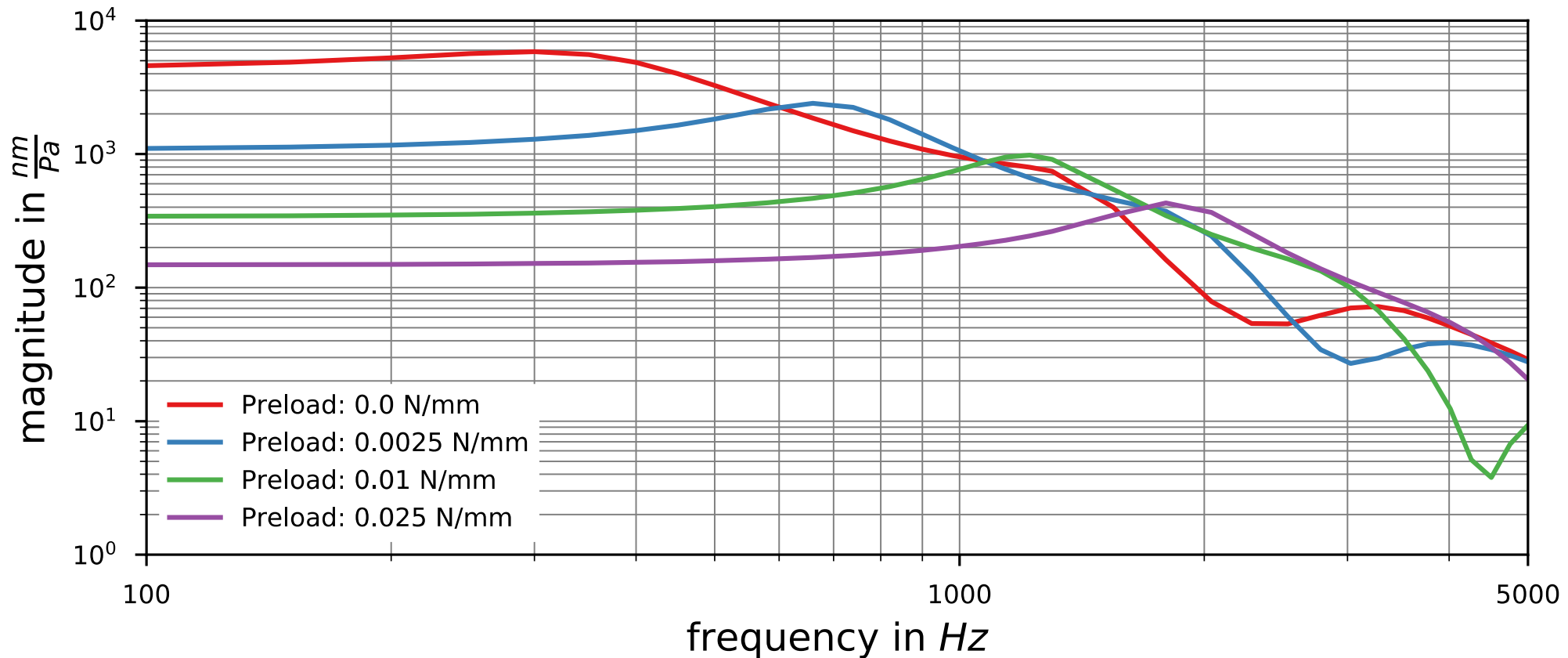


Measured oscillation of the tympanic membrane

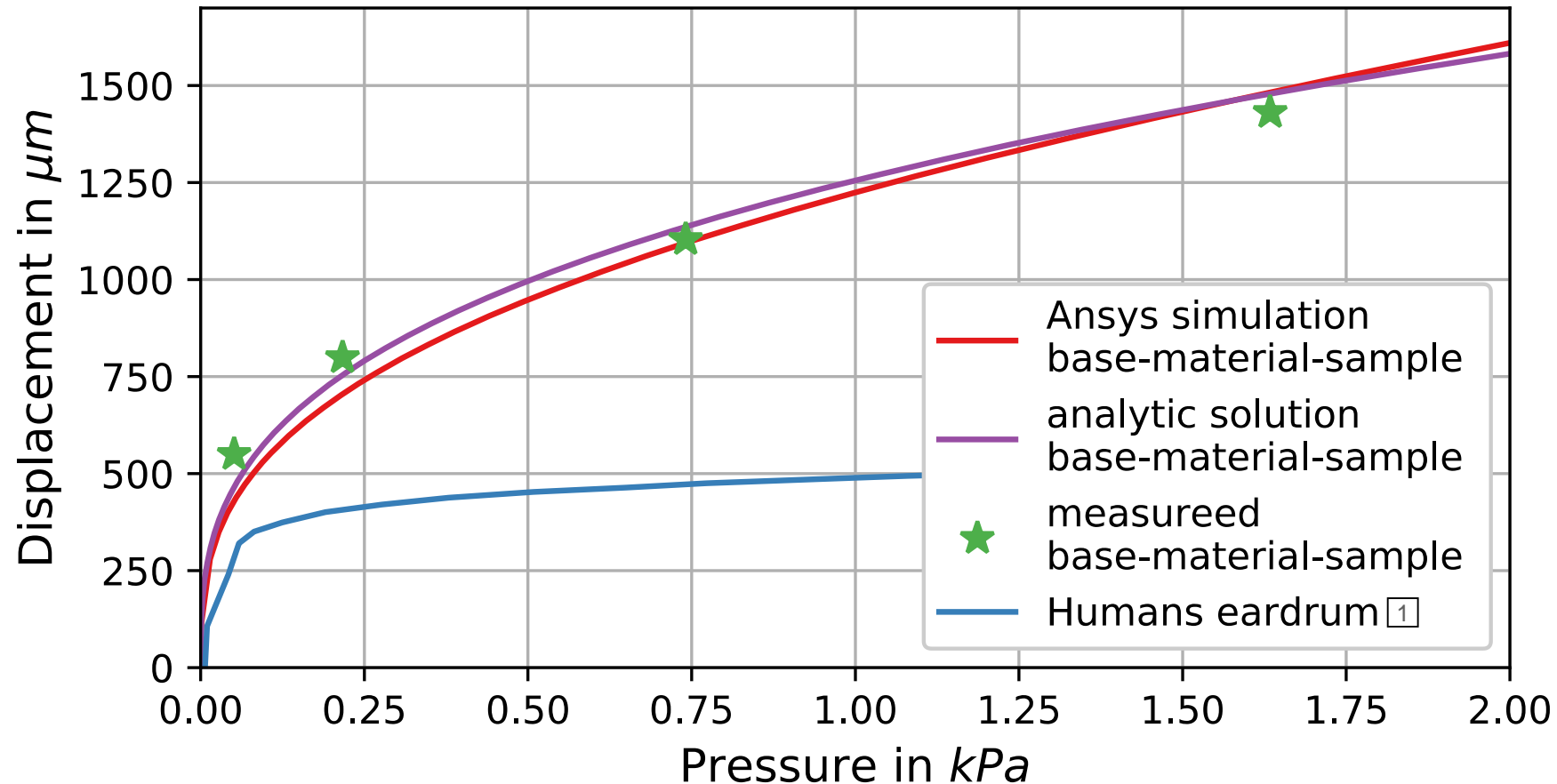


Influence of the simulated preload

■ Preload at the edge of the sample

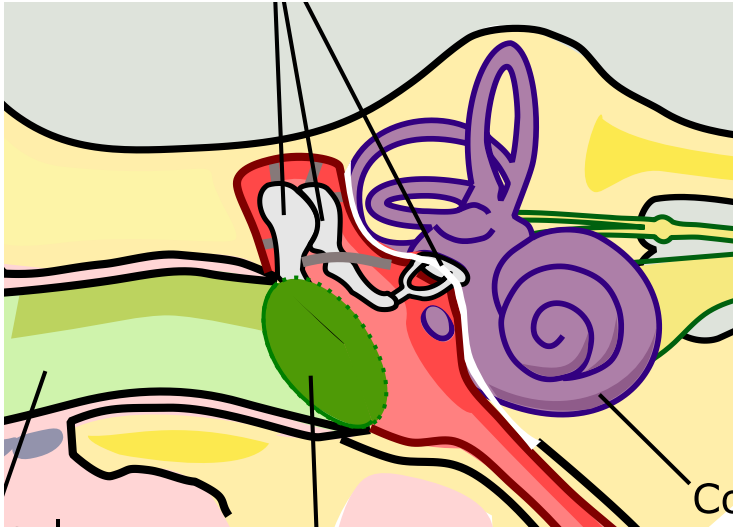
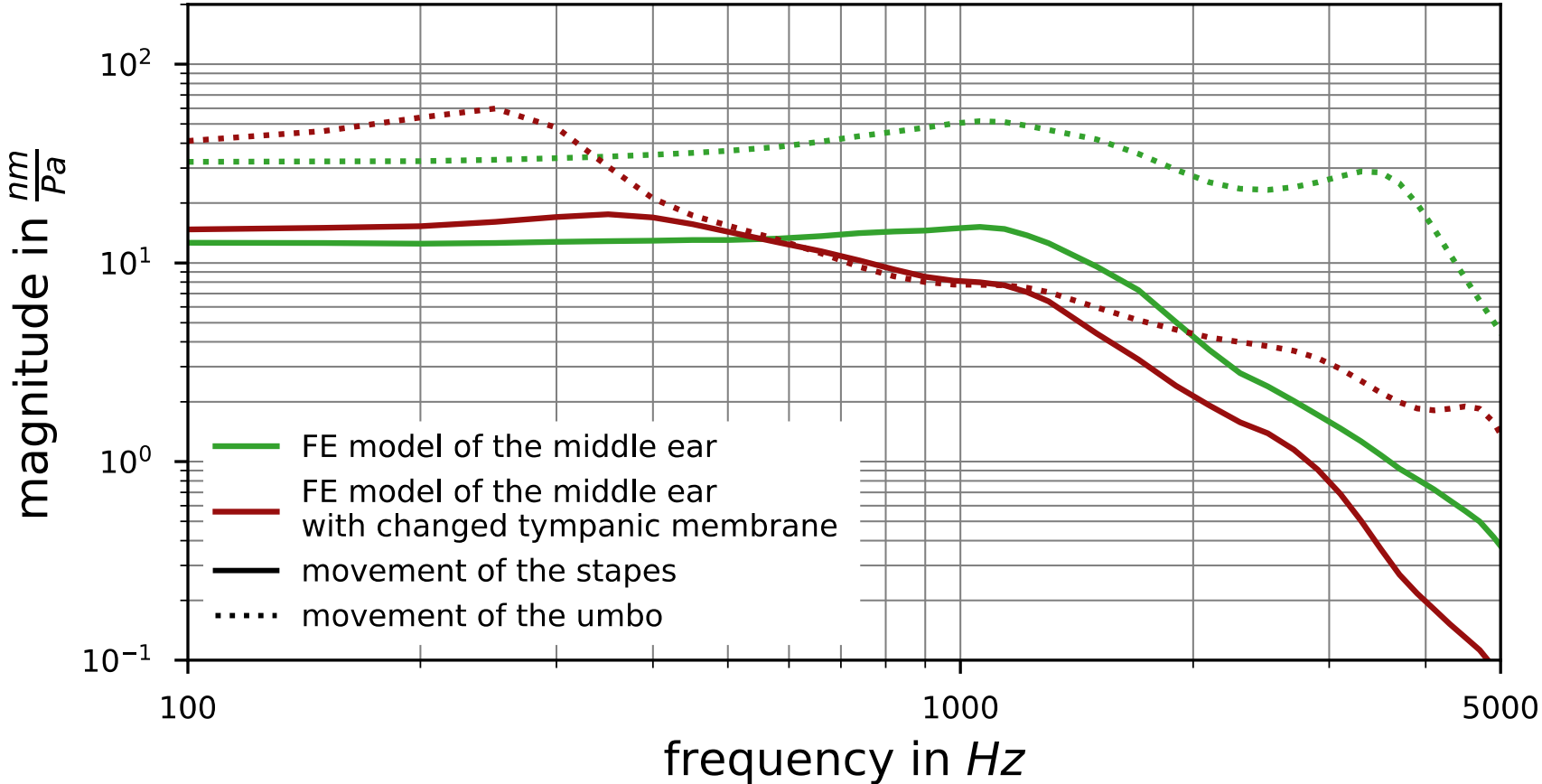


Applied quasi-static pressure



¹Zahnert, T., Hüttenbrink, K.B., Mürbe, D., Bornitz, M., 2000. Experimental investigations of the use of cartilage in tympanic membrane reconstruction. Am J Otol 21, 322–328.

Oscillation of middle ear in the FE model



Conclusion

- Many influences on the oscillation behaviour
- Good validation of model for applied quasi static pressure with analytic solutions
- Further optimization of the geometrical shape of the samples are necessary

Thank you very much for your attention.

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