KU LEUVEN

ACOUTECT

ACOUTECT: A sound fundament for our future buildings

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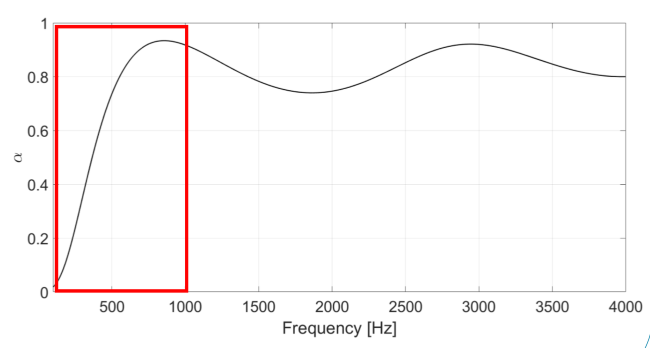
This poster introduces the ACOUTECT Marie-Curie ITN project and the works of ESRs 7 and 8.

Augusto, ESR 7: Development of acoustic resonant metamaterials for building applications

Coupled coiled resonators for sound absorption in low frequencies

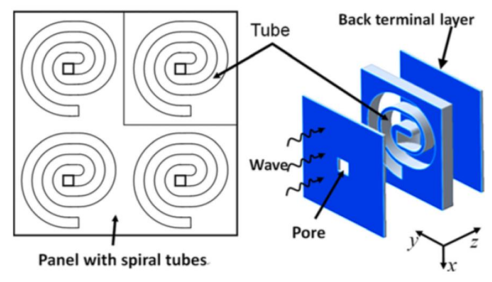
Foams: bad α in low frequencies



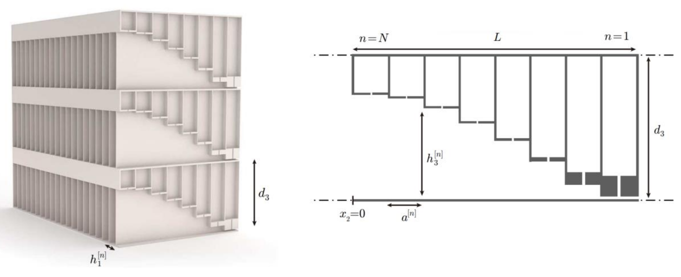
Current mostly applied absorber

Some current solutions for absorption in lower frequencies

Helmholtz Resonators



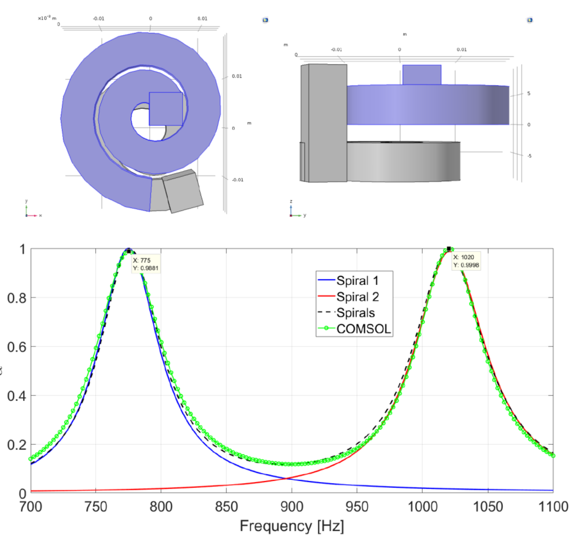
Coiled tubes [1]



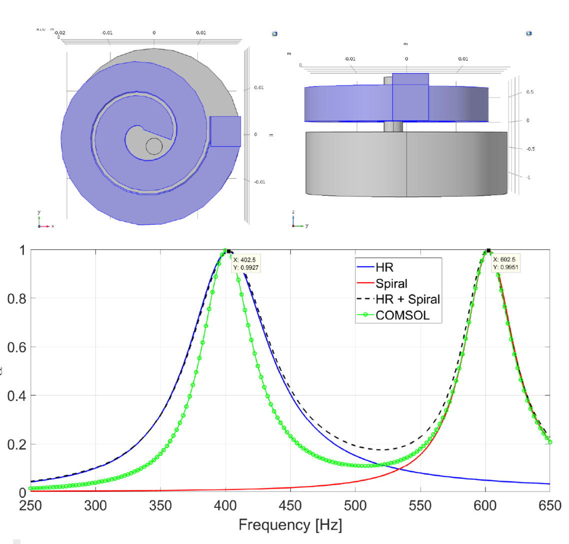
RTA absorbers [2]

Current Research

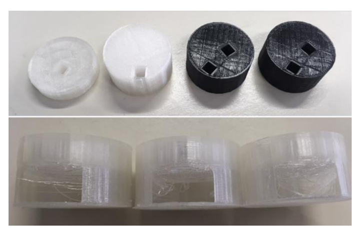
Coupled Spirals

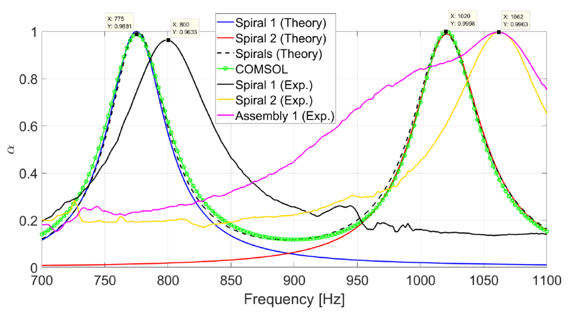


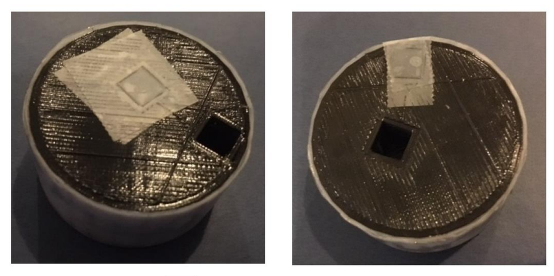
Coupled spiral with Helmholtz resonator

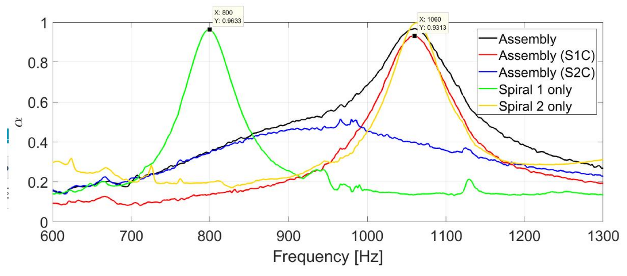


Experiments









References

[1] Cai, X., Guo, Q., Hu, G., & Yang, J. (2014). Ultrathin low-frequency sound absorbing panels based on coplanar spiral tubes or coplanar Helmholtz resonators. Applied Physics Letters, 105(12), 121901.

[2] Jiménez, N., Romero-García, V., Pagneux, V., & Groby, J. P. (2017). Rainbow-trapping absorbers: Broadband, perfect and asymmetric sound absorption by subwavelength panels for transmission problems. Scientific Reports, 7(1), 13595.

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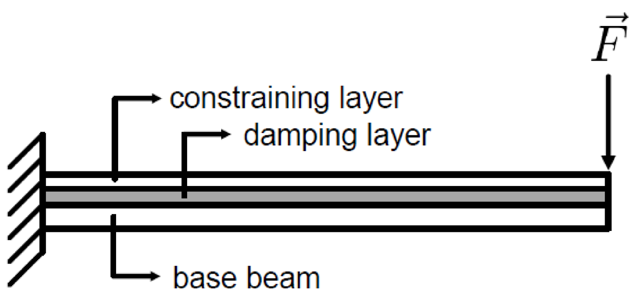
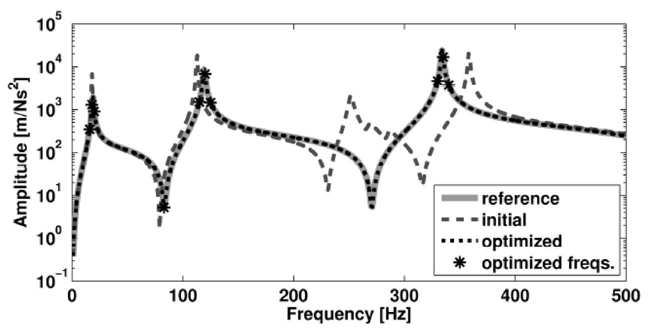
Felix, ESR 8: Time and cost efficient approaches for vibro-acoustic system identification

Efficient estimation by means of combining measurement data and numerical models

Previous Work [1]

- Inverse parameter estimation
  - Frequency response functions (FRF)
  - Parametric model order reduction (pMOR)

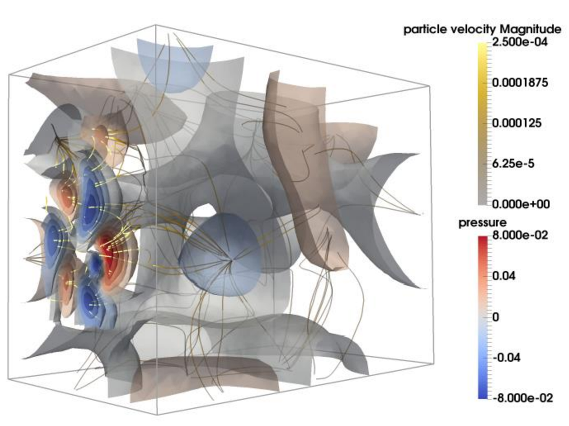




- Virtual sensing
  - Time domain
  - State-space description

$$\vec{x}_{k+1} = \mathbf{A}^d \vec{x}_k + \mathbf{B}^d \vec{u}_k + \vec{s}_k$$
$$\vec{y}_{k+1} = \mathbf{C}^d \vec{x}_{k+1} + \vec{r}_{k+1}\,,$$

  - Kalman filter



[1] van de Walle, "The Power of Model Order Reduction in Vibroacoustics.", 2018, PhD Thesis

Strategy

- Parameter estimation for poroelastic materials based on FRF
  - Frequency dependent pMOR

$$K_r(f) = V^T K(f) V$$

  - Optimization routine, avoiding local minima
- Inhomogeneous wave correlation
  - Wave number domain $u_{IWC} = e^{-ik(\theta)(1+i\gamma(\theta))(x\cos(\theta)+y\sin(\theta))}$
  - Correlation criterion $IWC(k_{IWC},\gamma_{IWC},\theta) = \frac{\left|\iint_S u.\bar{u}_{IWC}\,dxdy\right|}{\sqrt{\iint_S u.\bar{u}.dxdy \times \iint_S u_{IWC}.\bar{u}_{IWC}.dxdy}}$
- Auralization of building environment
  - Time domain modelling

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