Vibro-acoustic modelling and testing of poroelastic materials

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Poroelastic material modelling

- Vibro-acoustics = Noise & Vibrations
  - Porous materials as **damping materials**

$$\nabla \cdot \hat{\boldsymbol{\sigma}}^{s} + \omega^2 \tilde{\rho} \mathbf{u}^{\mathbf{s}} + \tilde{\gamma} \nabla p^{f} = 0,$$

$$\nabla^2 p^{f} + \omega^2 \frac{\tilde{\rho}_{22}}{\tilde{R}} p^{f} - \omega^2 \tilde{\gamma} \frac{\tilde{\rho}_{22}}{\phi^2} \nabla \cdot \mathbf{u}^{\mathbf{s}} = 0,$$

- Poro**elastic** material models
  - Complex and frequency dependent parameters
  - Deformable **skeleton** + acoustic **fluid**
  - Thermal, viscous-inertial and structural damping

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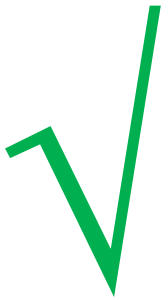
Experimental-numerical synergy

Rationale:



Complex environments with high-fidelity numerical models that can tackle complex vibro-acoustic fields over a broad frequency range (computational efficiency)

instead of

Dedicated test methods with dedicated (semi-) analytical models (diffuse field, normal incidence,...) and limited frequency range (assumption validity)

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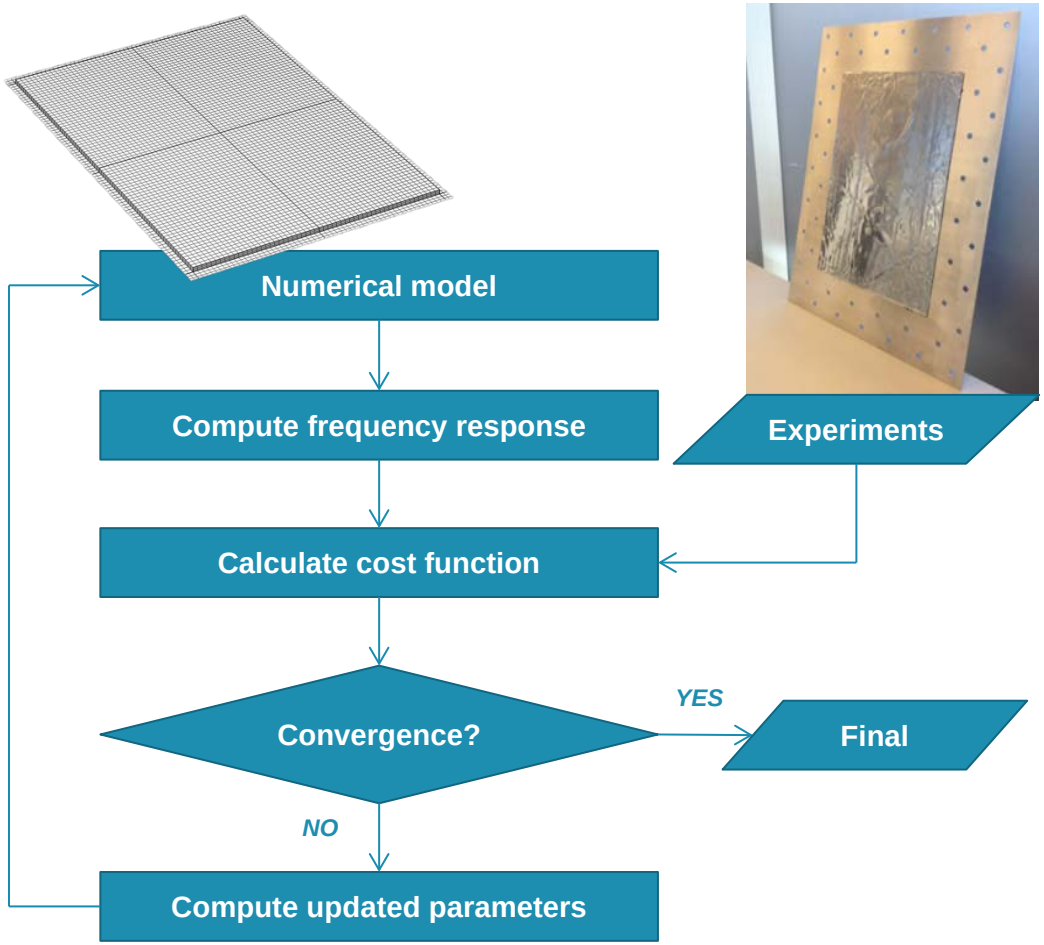
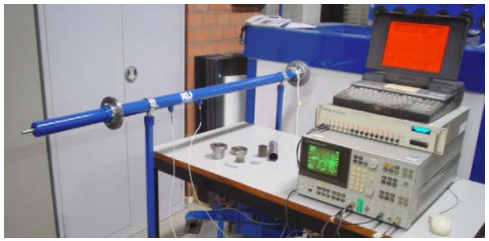
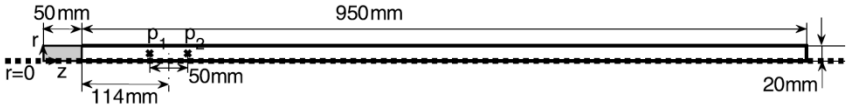
Inverse material characterisation

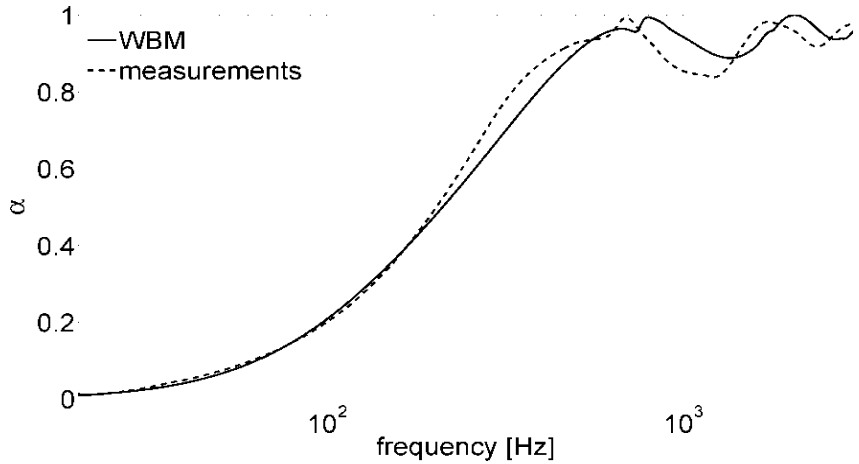


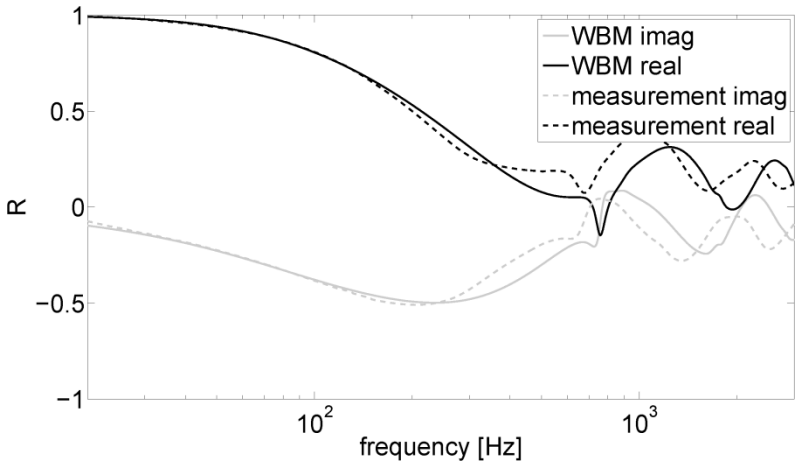
High accuracy impedance tube

Acoustic absorption/reflection/transmission testing in a **high accuracy impedance tube** (Kundt tube)









- R. Boonen, P. Sas, W. Desmet, W. Lauriks, G. Vermeir, Calibration of the two microphone transfer function method with hard wall impedance measurements at different reference sections, Mechanical Systems and Signal Processing 23 (5), 2009, pp. 1662-1671.
- J. Vanhuyse, E. Deckers, S. Jonckheere, B. Pluymers, W. Desmet, Global optimisation methods for poroelastic material characterisation using a clamped sample in a Kundt tube setup, Mechanical Systems and Signal Processing, in press, 2015.

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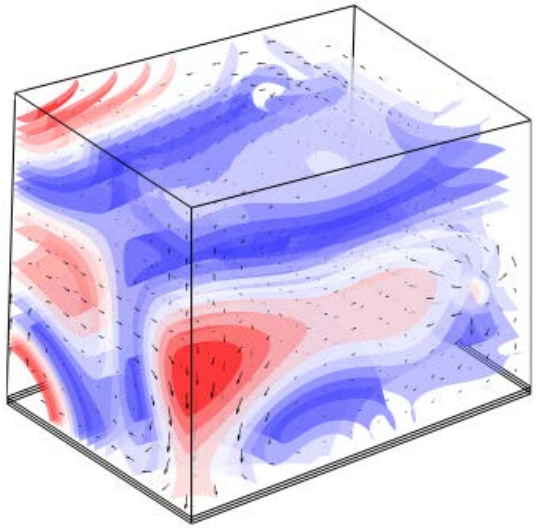
KU Leuven Soundbox

KU Leuven Soundbox:
A Small non standardised vibro-acoustic test setup



- Acoustic cavity
  - Absorption
  - Transmission
- Fully equipped

- Efficient numerical models to capture complex vibro-acoustic environment

- M. Vivolo, W. Desmet (sup.), D. Vandepitte (sup.), Vibro-acoustic Characterization of Lightweight Panels by using a Small Cabin, Ph.D. thesis, 2013.
- S. Jonckheere, W. Desmet (sup), D. Vandepitte (sup.), Wave based and hybrid methodologies fro vibro-acoustic simulation with complex damping treatments

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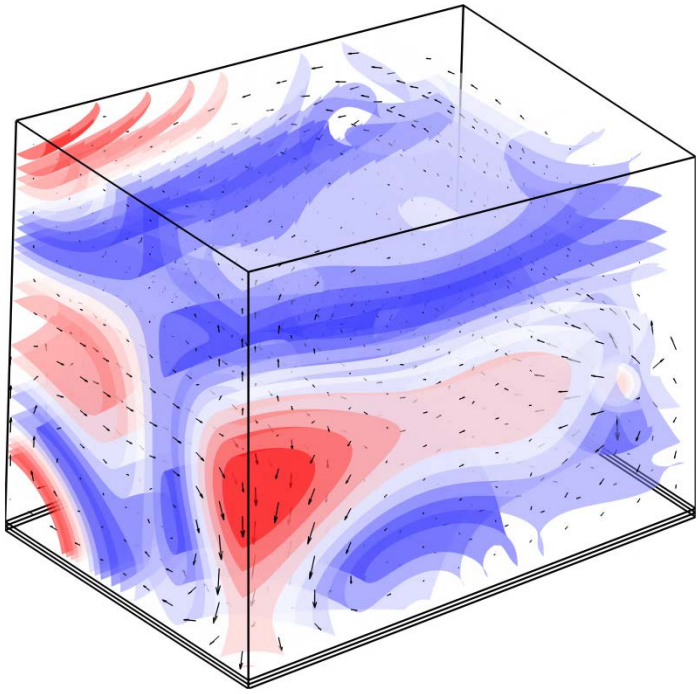

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