Acoustic Leak Detection in Building Envelopes – Laboratory and Field Tests

Airtightness in Practice: Long-Term Performance, Field Evidence, and Innovative Detection Methods

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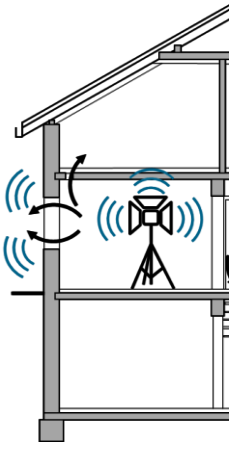
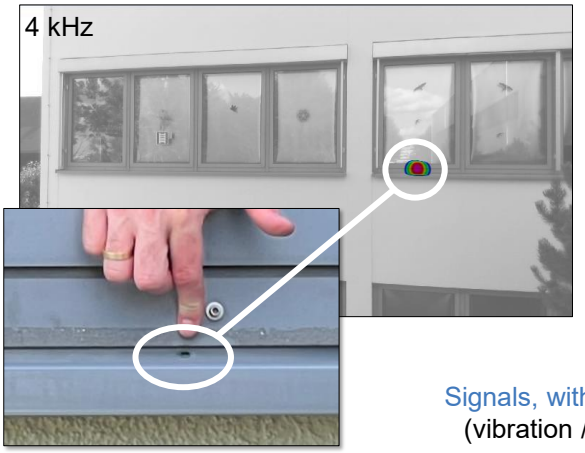
Introduction

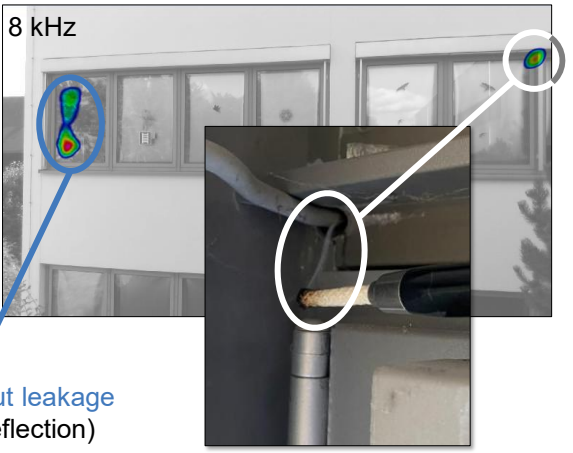
- **Leak detection: Why acoustic?**
  - Sound propagates through air leaks
  - Scanning applications in the construction industry
  - Source localization using an acoustic camera
- **Possible advantages**
  - No Δp or ΔT required
  - Large areas can be tested / no manual search
  - → Time savings
- **Promising field tests**
  - Details in presentation [1] and paper [2]



Introduction



Hole in window frame



Signals, without leakage
(vibration / reflection)

Cable fairlead to the blind

Laboratory: Airtight test facility ATLAS

Dimensions:
(2 x 2,5 x 3) m³

Residual leakage:
q_{50}=0.1 m³/h

Acoustic camera

IR camera

Loudspeaker

Exchangeable
test specimens

Measuring fan

ATLAS: Adaptable Testing Laboratory for Air Sealing

Laboratory: Soundproofing of ATLAS

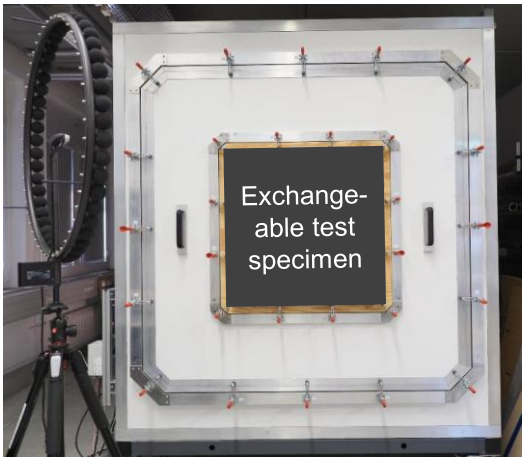
Outside:

Inside:
Before soundproofing

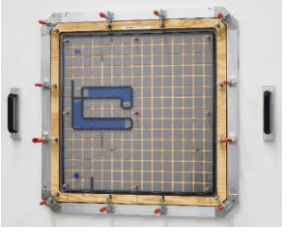
Inside:
After soundproofing

→Significantly higher sensitivity & better results

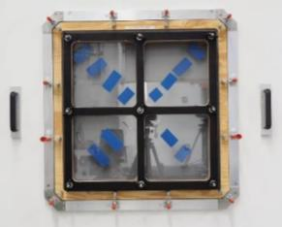
Exchangeable test specimens



Labyrinth system



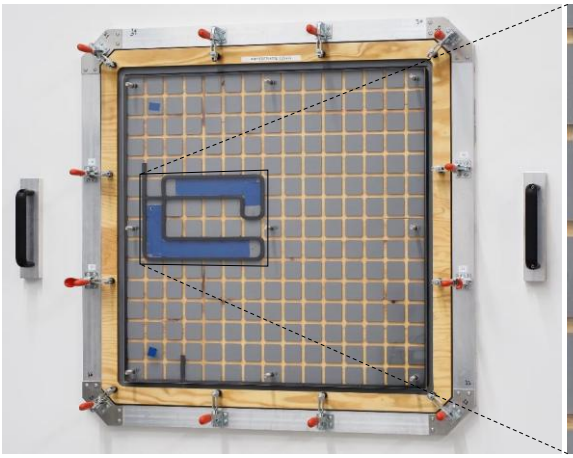
Sandwich system

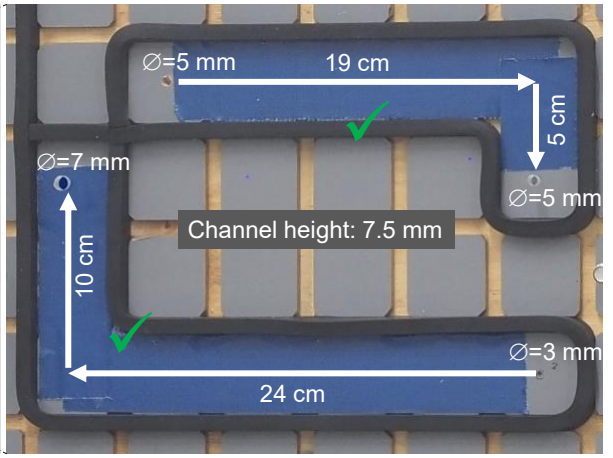


Detailed explanation of test specimens in [3]

Results Labyrinth system

q_{50}=0.32 m³/h



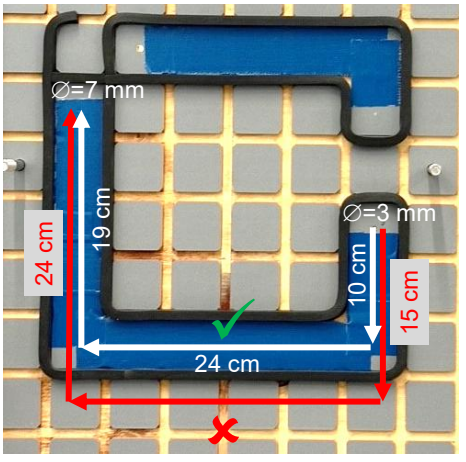


q_{50}=0.16 m³/h

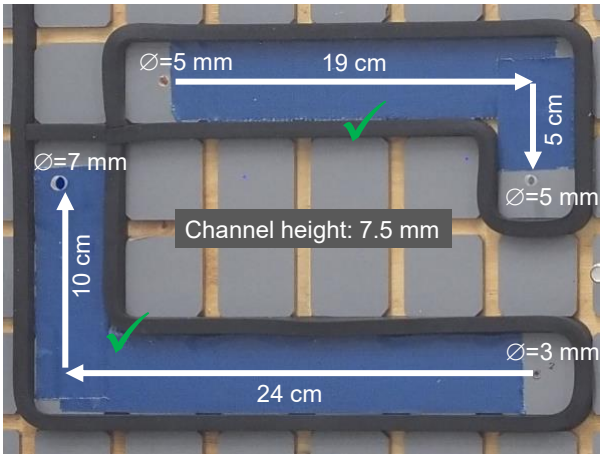
7

Results Labyrinth system

q_{50}=0.32 m³/h



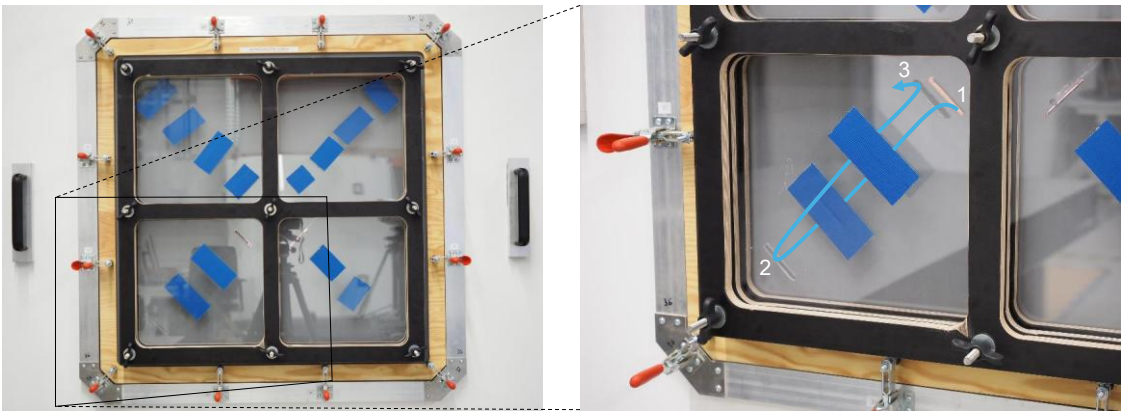
q_{50}=0.14 m³/h



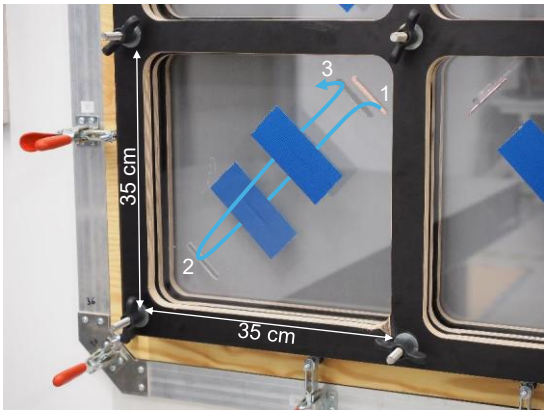
q_{50}=0.16 m³/h

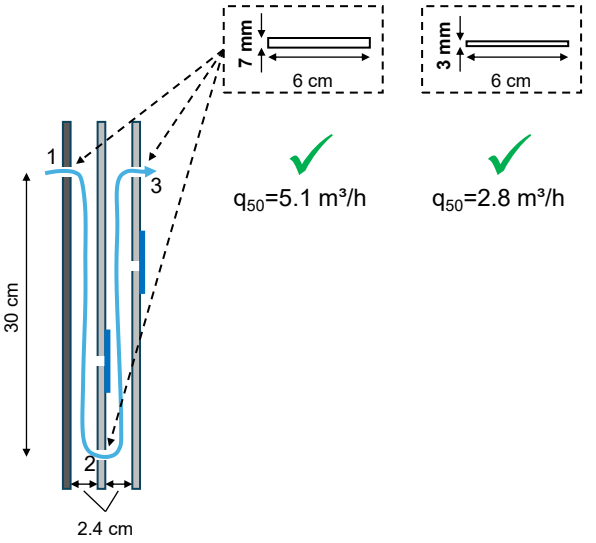
8

Results Sandwich system (multilayered)

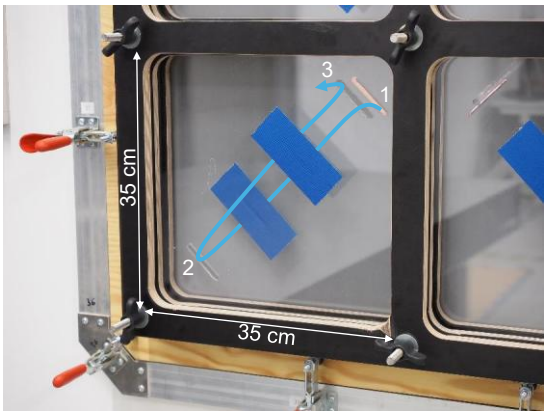


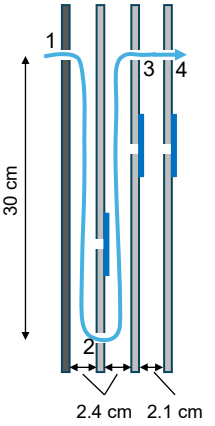
Results Sandwich system (multilayered)

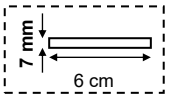


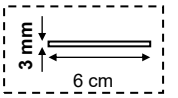


Results Sandwich system (multilayered)





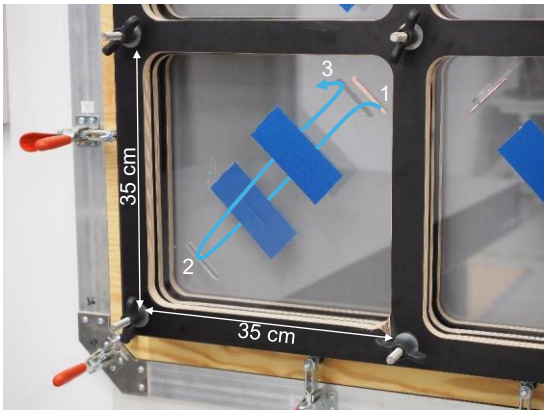


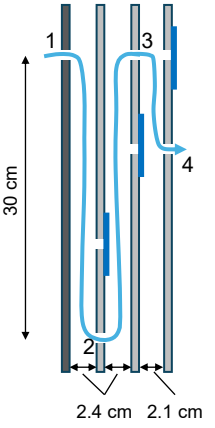


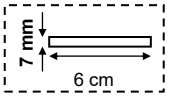
✓ q_{50}=4.8 m³/h

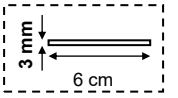
✗ q_{50}=2.5 m³/h

Results Sandwich system (multilayered)









✓ q_{50}=4.8 m³/h

✗ q_{50}=2.5 m³/h

✗ q_{50}=4.5 m³/h

Field tests: Speaker setup

Ultrasonic
spherical transmitter
40 kHz

Low-frequency dodecahedron
white noise
90 Hz to 9 kHz

High-frequency
linear frequency sweep
10 – 22 kHz

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Field test example: Attic

9

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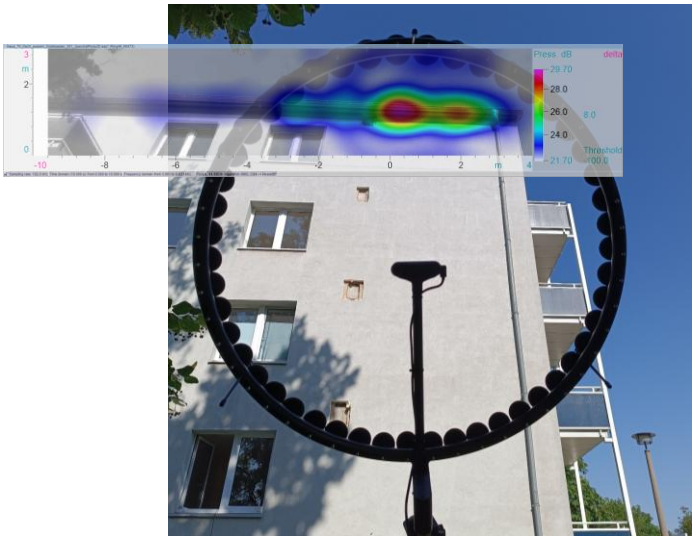
Field test example: Attic

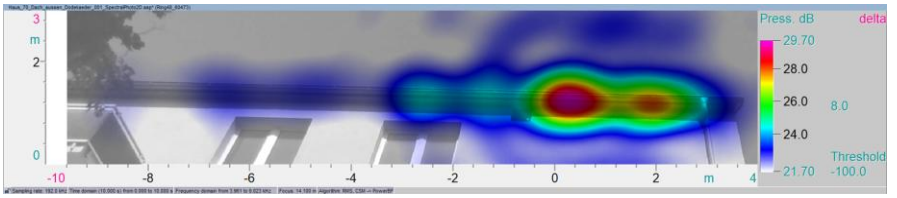
Low-frequency
dodecahedron
4 – 9 kHz

Field test example: Attic

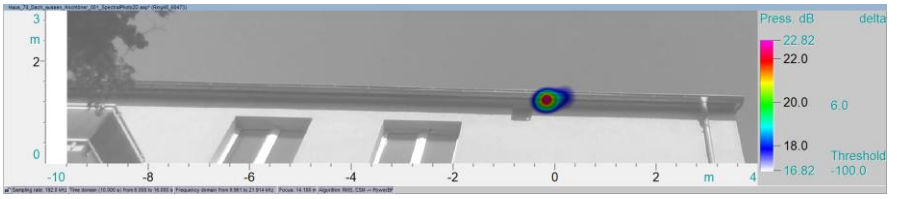


Low-frequency
dodecahedron
4 – 9 kHz

Field test: Speaker frequency



→ Results depend on speaker frequency



Low-frequency
dodecahedron
4 – 9 kHz

High-frequency
tweeter
10 – 22 kHz

10

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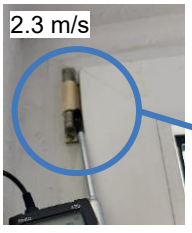
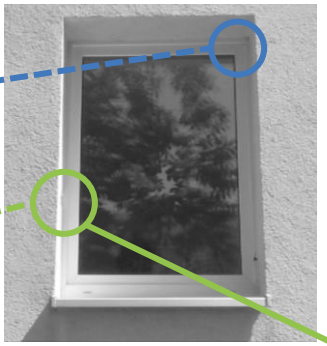
Field test example: Window





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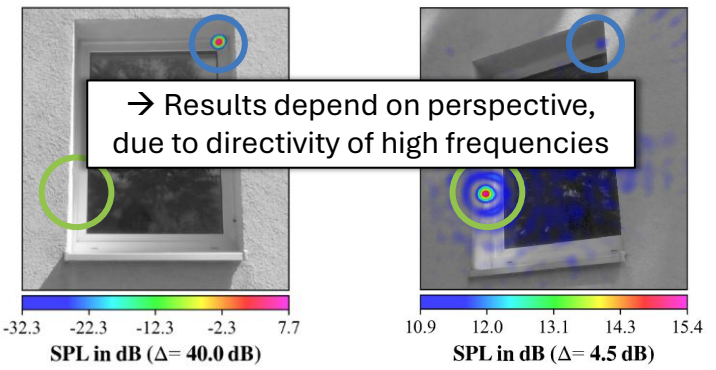
Field test: Directivity & Perspective

High-frequency
tweeter
10 – 22 kHz

Change of perspective

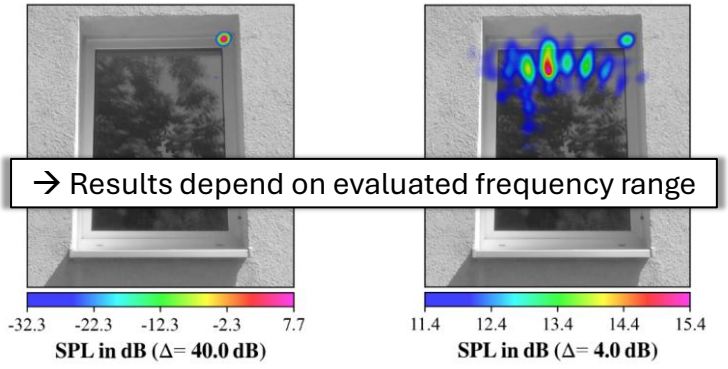


Field test: Evaluated frequency range

High-frequency
tweeter
10 – 22 kHz

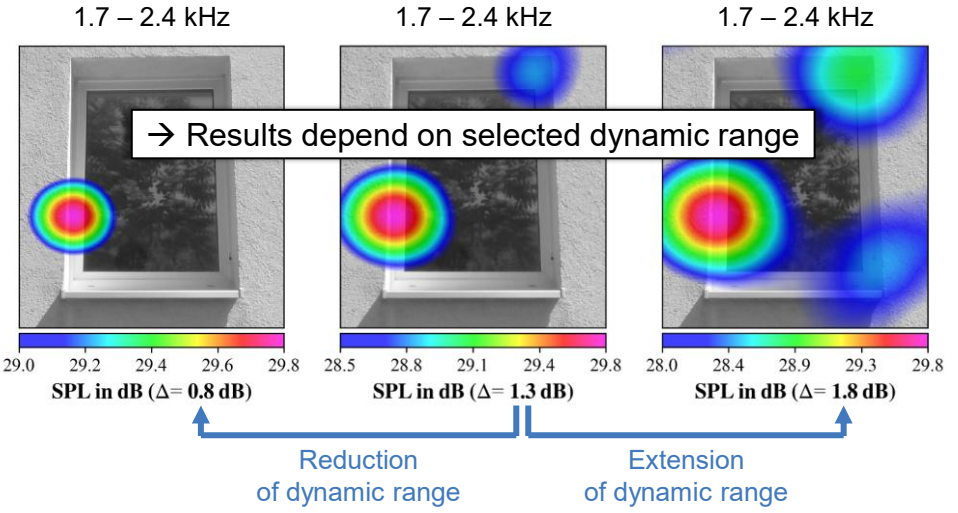
Extension of the frequency range

17.6 – 18.1 kHz → 15.0 – 20.0 kHz



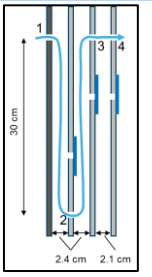
Field test: Selected dynamic range

Low-frequency
dodecahedron
90 Hz – 9 kHz



Conclusion & Outlook

- Leakages with complex paths are detectable
  - Including small holes, several bends, cavities and multilayered paths
- Successful trials on real buildings
  - Large areas, distances of 15 m
  - Evaluation and interpretation require experience
- Promising method for reliable and efficient leak localization
  - No pressurization needed, no manual search for leaks
- Currently investigating
  - Suppress interference signals
  - Increase automation in evaluation process
  - Combination of acoustic and thermographic methods



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Presentations file, pages 131–141.
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Questions?

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