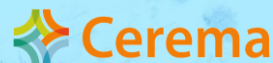


# Combining IR and acoustic methods

An under-development method to locate air leakage paths

Benedikt Kölsch, Björn Schiricke – DLR (German Aerospace Center)

19.06.2023

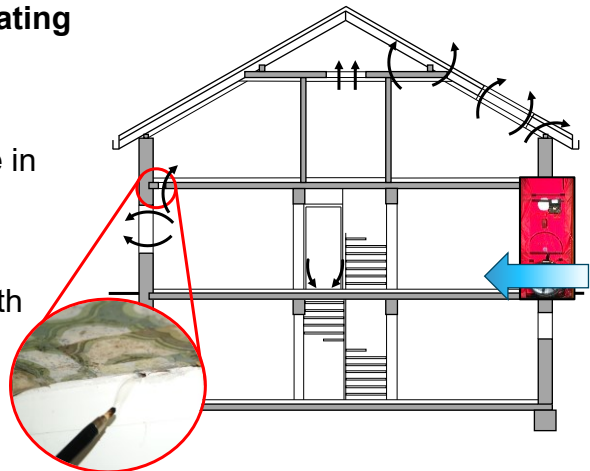


1

## Motivation



- **Uncontrolled airflow** in buildings → responsible for significant share of **heating** and **cooling energy**
- **Knowledge of leak location and size** in building envelopes is crucial
- **Leakage detection** in combination with blower-door is **time-consuming**



2

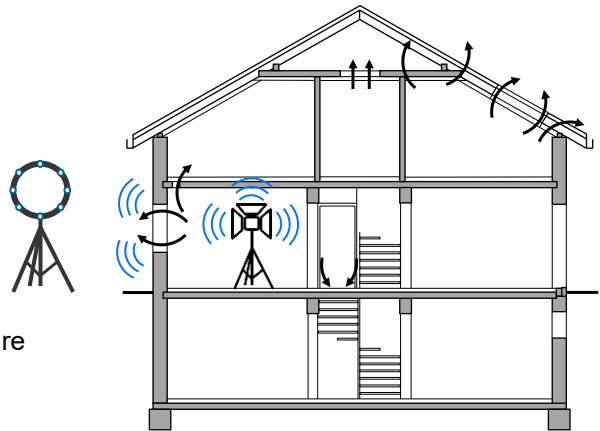
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2

## Acoustic Approach



- **Sound** takes predominantly the **same paths** as **air** in fan pressurization method
- Possible approach to identify leak locations in building envelopes: **microphone array + speaker**
- **Advantages:**
  - Independent from pressure and temperature differences
  - Scanning of large areas possible



3

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## Acoustic Measurement Setup

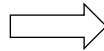


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4

# Acoustic Measurement Setup

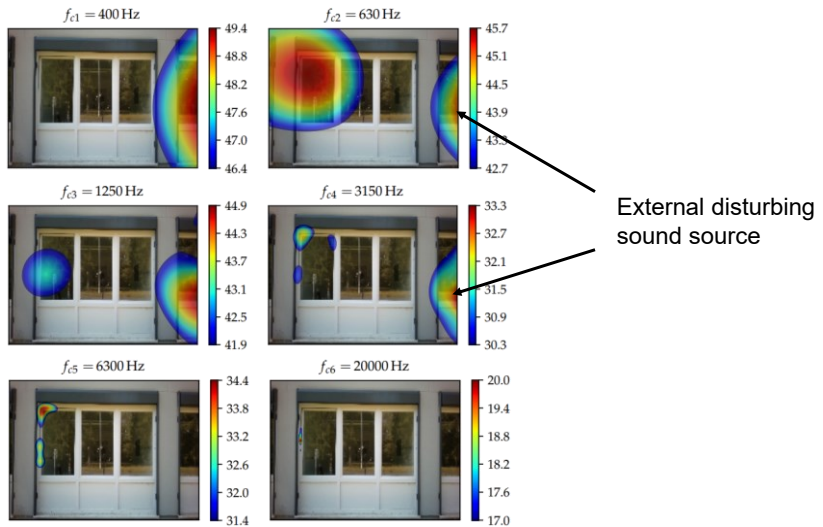


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# Acoustic Measurement: Tilted Window



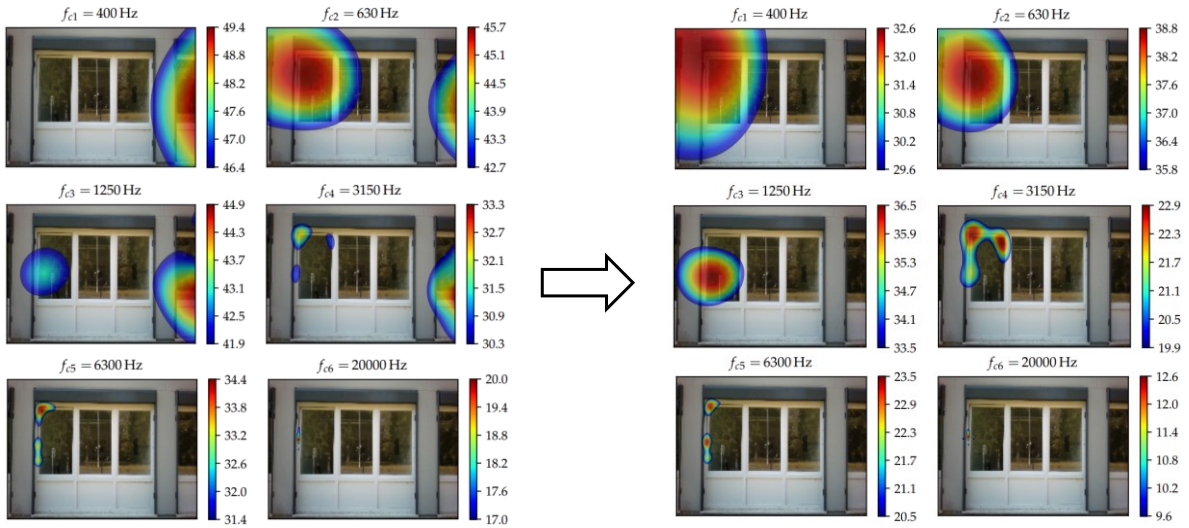
External disturbing sound source

6

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# Acoustic Measurement: Tilted Window

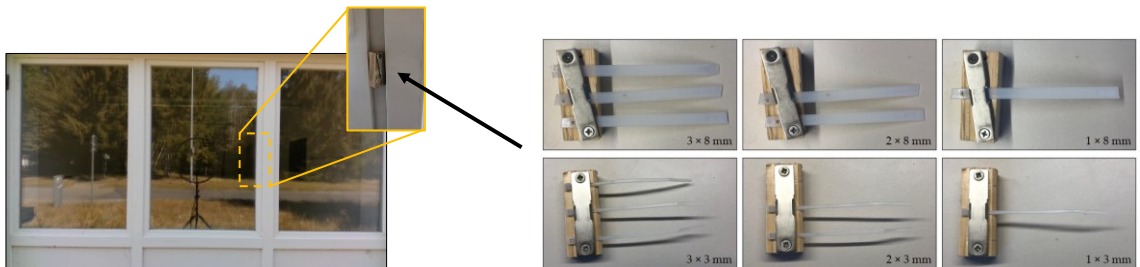


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# Acoustic Measurement: Cable Ties Window

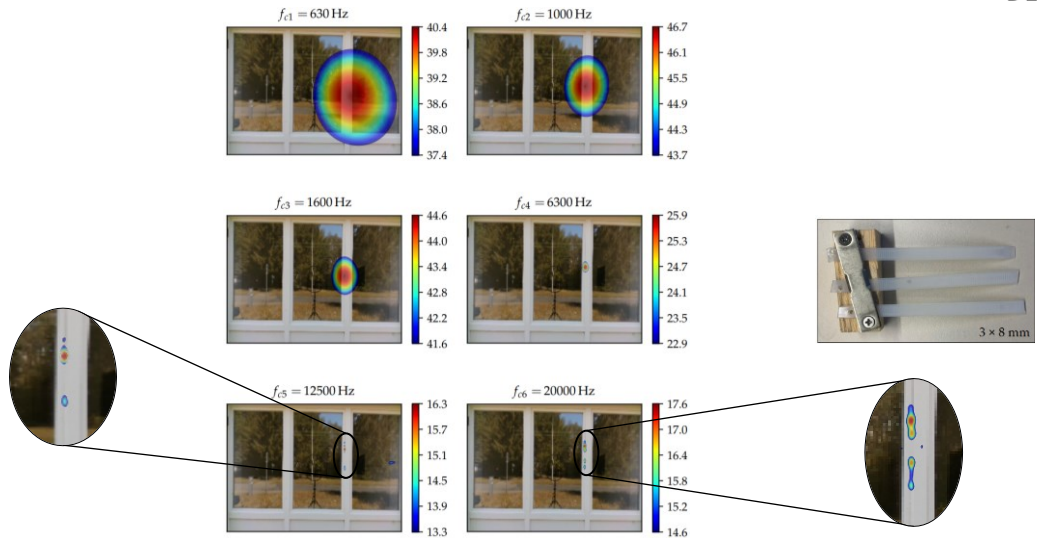


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# Acoustic Measurement: Cable Ties Window

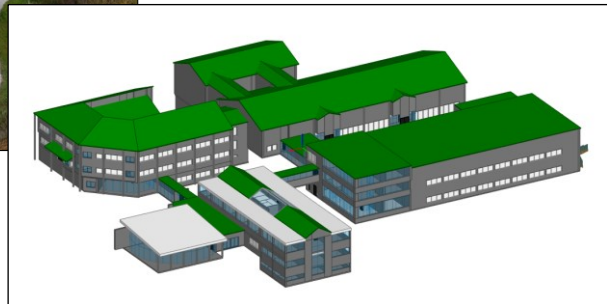


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# Acoustic Measurement: Large Field Study

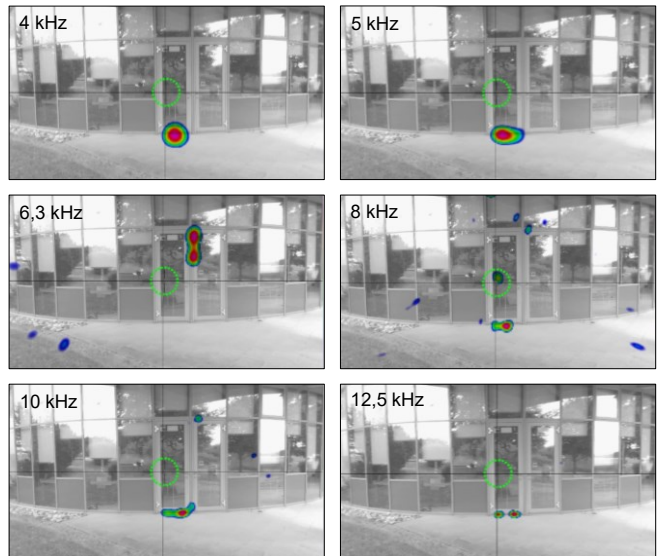


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# Acoustic Measurement: Leak Detection on Entire Facades

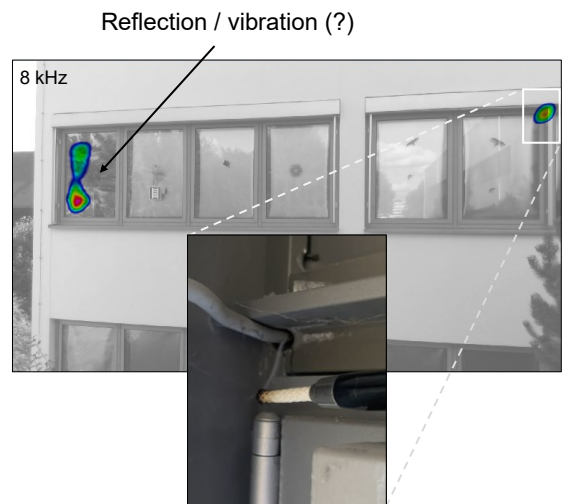
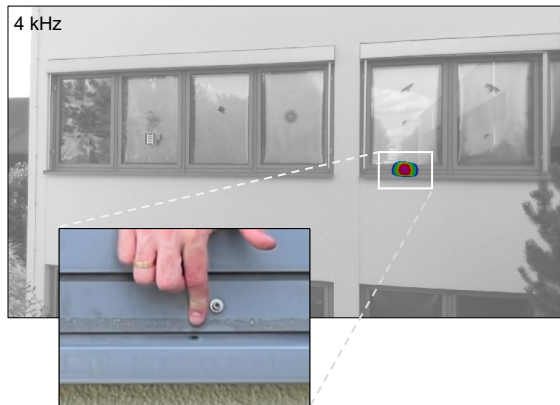


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# Acoustic Measurement: Evidences of Leaks Found

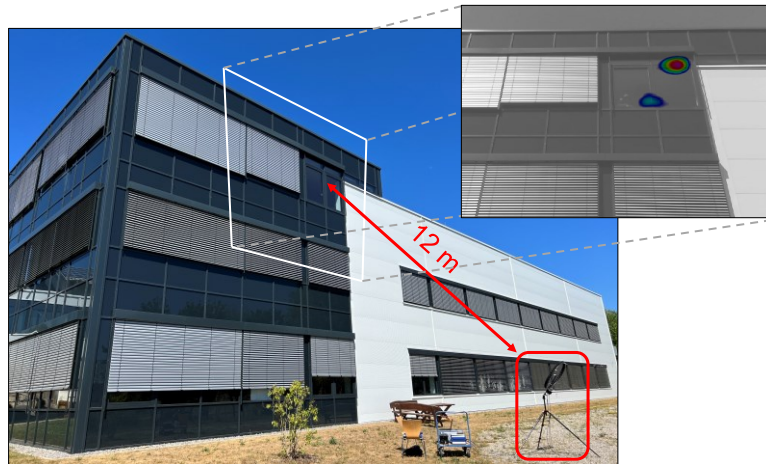


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## Acoustic Measurement: Large Distances Possible



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## Acoustic Measurement: Strengths and Weaknesses



- Large-scale façades scan possible
- Visualization of sound sources possible



- Susceptible to acoustic interference sources
- So far, estimation of leak size is difficult / hardly possible yet
- Sometimes difficult to distinguish between leakage, reflection or vibration



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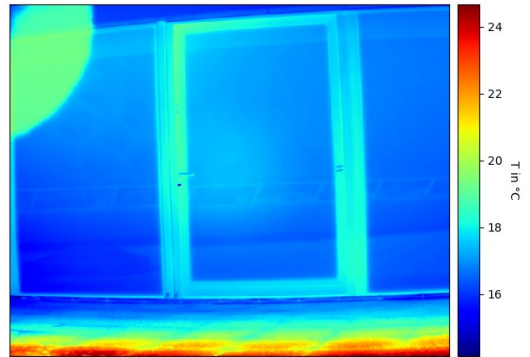
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## Infrared Measurement Outside



- Another possible method to find leaks:  
**Infrared Thermography**
- Constraints of IR measurements:
  - High temperature difference between inside and outside
  - Stable temperature differences
  - No solar radiation
  - Low wind speed

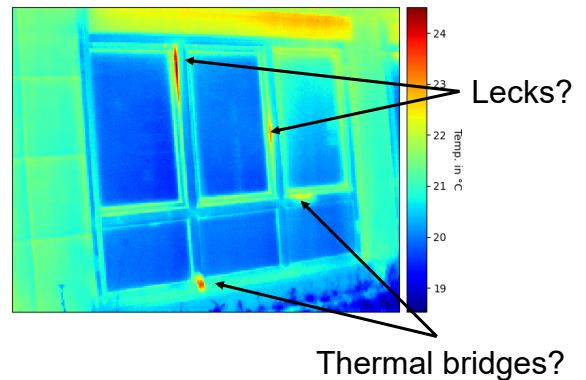


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## Infrared Thermography



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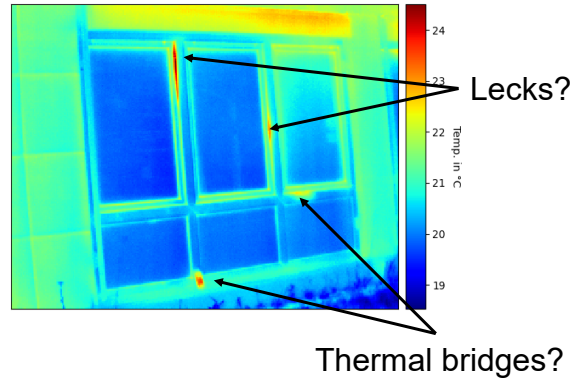
# Infrared Thermography: Strengths and Weaknesses



- Large-scale façades scan possible
- Display of thermal image of façade



- Susceptible of change in environmental conditions
- Sometimes difficult to distinguish between leak and thermal bridge

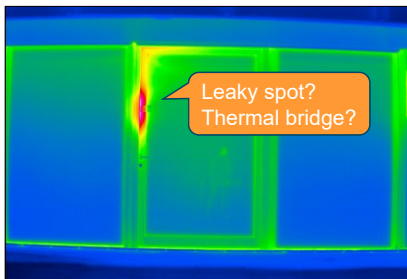


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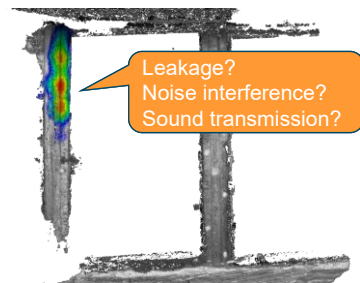
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# New project: Develop method for combining these methods



Thermal image of the IR camera



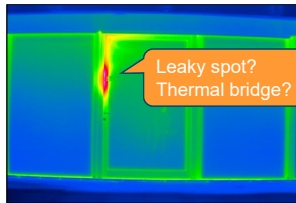
3D model of the acoustic camera with sound localization

18

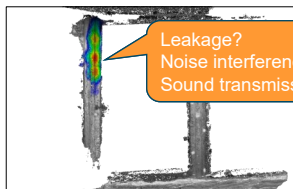
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## New project: Develop method for combining these methods



Thermal image of the IR camera



3D model of the acoustic camera with sound localization



Combination of infrared and acoustic camera

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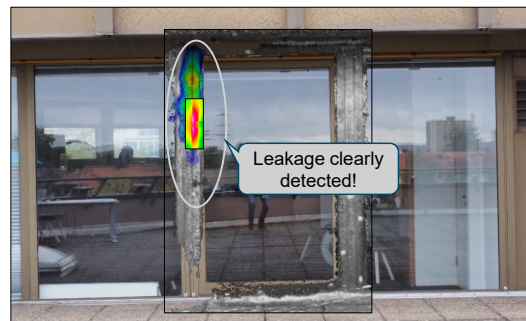
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## Possible advantages



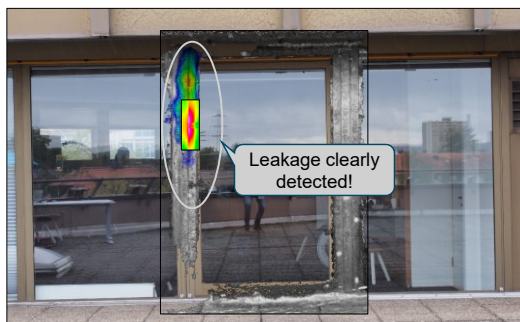
- Combination of infrared thermography and acoustic camera to **identify relevant leaks in the building envelope** over large areas.
- **Less sensitive to weather conditions** (wind, outside temperature) that otherwise affect thermal imaging analysis
- Easy **mapping of leakages** on the facade surface.
- (Possibly) **prioritization** of leakages.
- **Scalability**, ease of use, standardized application, easily interpretable results



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# Thank you!

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