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Workshop at MCE – Mostra Convegno Expocomfort

## “Heat Pump Acoustics: From Sound Signatures to Installation Impact”

**25 March 2026** | 10:00-12:00 | Room Libra | Fiera Milano

For further information:

<https://heatpumpingtechnologies.org/project51/>

<https://heatpumpingtechnologies.org/project63/>



# URBAN ACOUSTICS IMPACT OF HEAT PUMPS AND DIGITALLY ASSISTED HEAT PUMP PLACEMENT



Christoph Reichl, David Göcke, Christian Kaseß, Michael Wernhart



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# CONTENT

**Database Creation**

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**Estimation of sound propagation using a web-based 2D-tool**

**Annex 51 Task 6 “Psychoacoustics”**





## Placement Impact on Heat Pump Acoustics

IEA HPT

Annex 63

### Building Impact of Heat Pump Acoustics

- Impact on the owner
- Structure borne noise & vibrations
- Refinement of numerical and measurement methods

### Urban Acoustics Impact of Heat Pumps

- Impact on the neighborhood
- Interaction of multiple heat pumps
- Low frequency contribution to the acoustic signature
- Operational management impact

# IEA HPT ANNEX 63

5th hybrid working meeting in Salford

## TASK 2

### Psychoacoustics of Heat Pumps

- Continuation of IEA HPT Annex 51
- Panel tests
- Low frequency noise
- Heat pump interaction

### Digitally Assisted Heat Pump Placement

- Deployment of enhanced 2D tool including multiple heat pumps
- Augmented reality powered 3D heat pump placement tool
- Implementation of installment guidelines into tools

### Dissemination

- Tools on website and handhelds
- Updated installation guidelines
- Deliverable documents
- Publications & contributions to conferences
- Workshop

# Database Creation

## **Description:**

Investigate the influence of heat pump placement on acoustics, focusing on neighbourhood effects, interaction of multiple heat pumps, and low-frequency noise contributions.

## **Objectives:**

- Create a comprehensive database for sound intensity and power measurements of air source heat pumps.
- Capture statistical frequency and directional behaviour of noise emissions.
- Develop a questionnaire through a survey to collect relevant data from participants.

## **Expected Outcomes:**

- A well-structured database that provides insights into the acoustic performance of heat pumps.
- Enhanced understanding of how heat pump placement affects noise levels in residential areas.

# Database Creation

- Develop a Database for Heat Pump Measurements (Sound-Power-Level, 5 surfaces, Frequency-dependent)

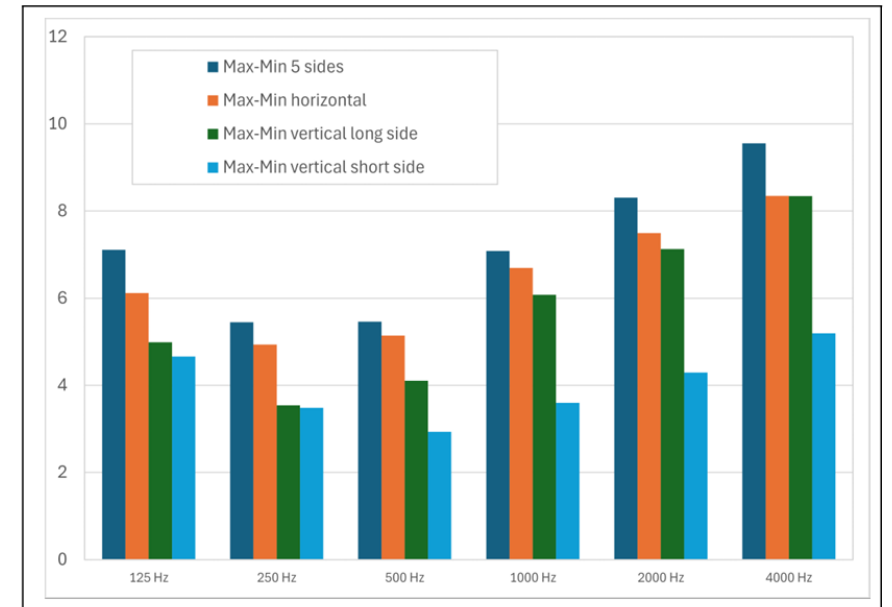


- Database (44 Datasets from CETIAT, AIT, IBP, EMPA)
- Paper Forum Acusticum EURONOISE 2025



IMPROVE HEAT PUMP PLACEMENT CONSIDERING FREQUENCY  
RESOLVED ACOUSTIC DIRECTIVITY DATA: CREATION OF AN OPEN  
DATABASE

Reichl Christoph<sup>1\*</sup> Bessac Francois<sup>2</sup> Klein Georg<sup>1</sup>  
Stöckl Luisa<sup>1</sup> Czuka Martin<sup>1</sup>  
<sup>1</sup> Center for Energy, AIT Austrian Institute of Technology, Vienna, Austria  
<sup>2</sup> CETIAT, Villeurbanne, France



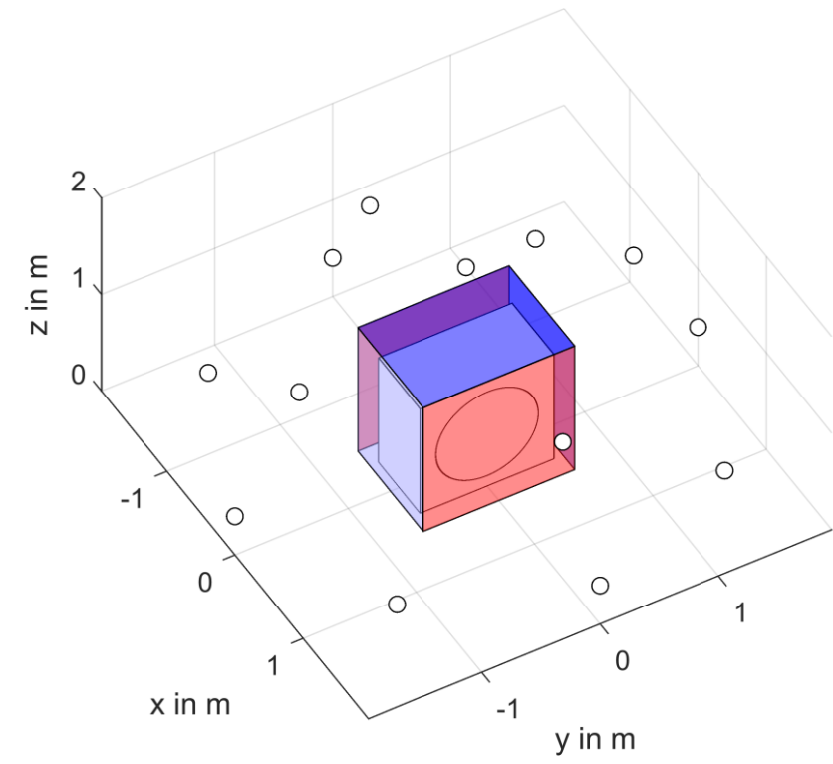
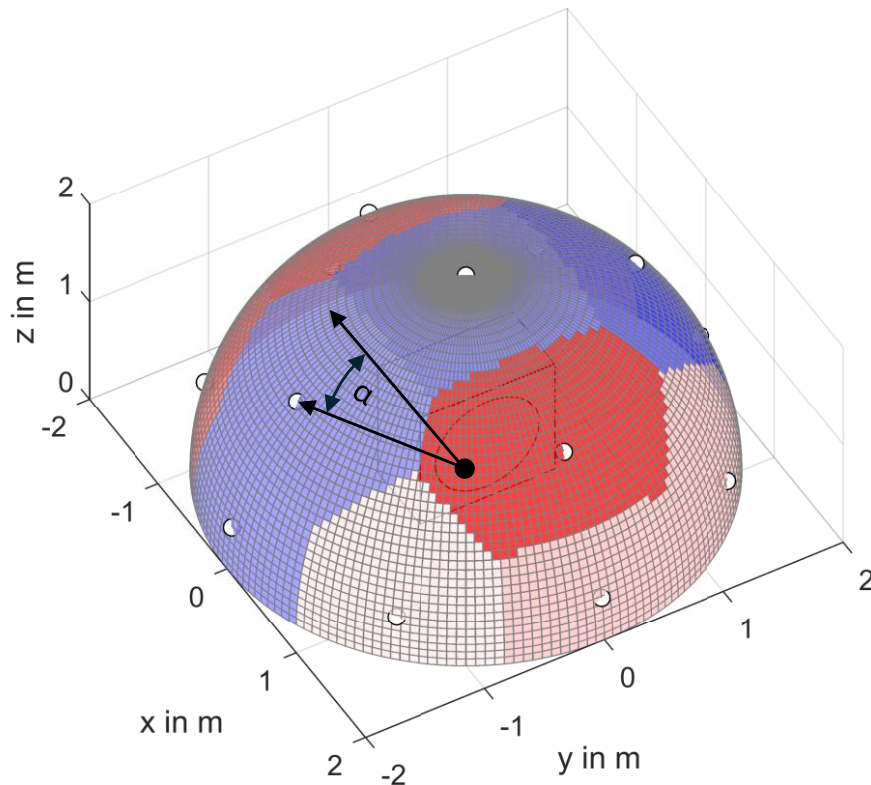
**Figure 7.** Max-Min directivity, averaged on the 27 data sets.

[Improve heat pump placement considering frequency resolved acoustic directivity data: creation of an open database](https://dael.euracoustics.org/confs/fa2025/data/articles/000460.pdf)

<https://dael.euracoustics.org/confs/fa2025/data/articles/000460.pdf>

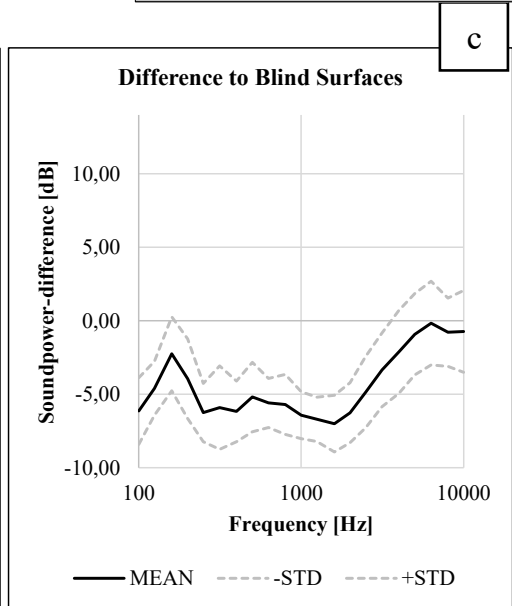
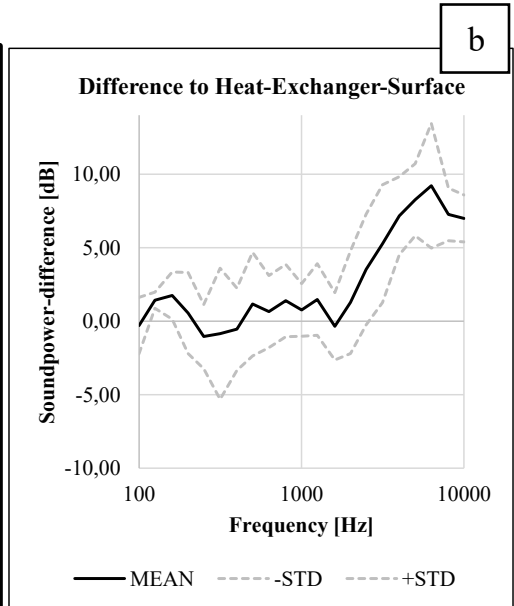
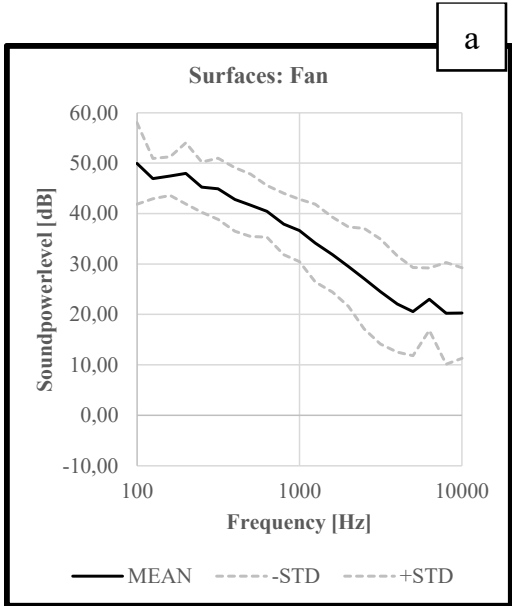
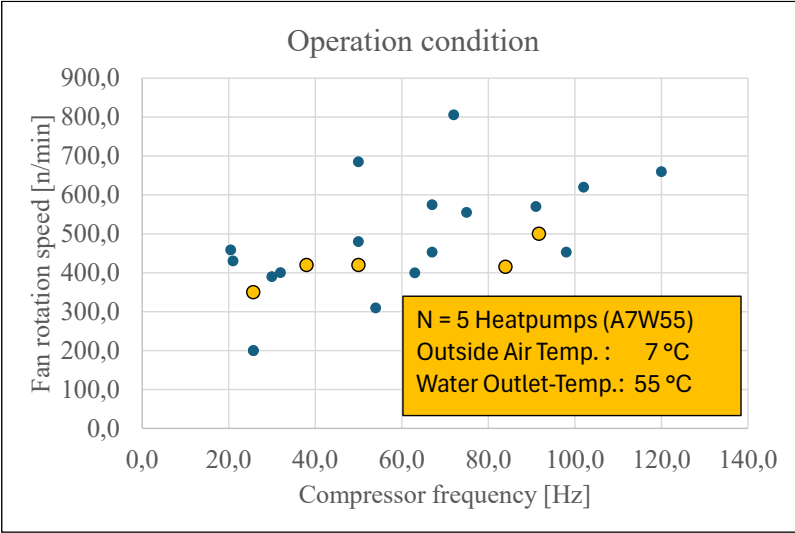
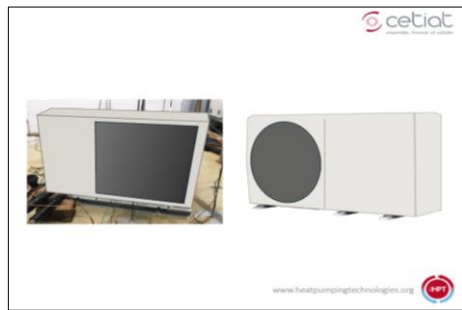
# Database Creation

- Development of data-conversion (Sound-Power, Dome to 5 Surfaces)



# Database Creation

- Paper HPC Vienna 2026:



[Air-2-Water Heat Pump Database - Project 63](https://heatpumpingtechnologies.org/project63/database/)

<https://heatpumpingtechnologies.org/project63/database/>

# Workshop

15<sup>TH</sup> IEA  
HEAT PUMP  
CONFERENCE

MAY 26–29, 2026 | HOFBURG  
  
VIENNA 2026



## - Workshop 7: Breaking barriers – Accelerating Heat Pump Deployment

**Background:** Heat Pumps are a corner stone in the energy transition. To reach energy and climate goals more than 50 % of buildings should be heated with heat pumps in 2050 according to IEA Net Zero by 2050 scenario. The technology is energy-efficient, secure, flexible and climate friendly. Transition and massive change of technical systems in a non-mature market is a journey with barriers to overcome. Barriers including policies, administrative burdens, affordability issues, lack of skills and information and user centric questions like trust and knowledge.

**About the workshop, purpose and objective:** The workshop will include updates about different initiatives aiming at accelerating heat pump deployment going on in different parts of the world, as well as findings from user related research. We will combine presentations, oral interventions, panel discussions and dialogue in breakout sessions. The overall idea is to share knowledge and identify important areas for collaboration to find solutions for existing barriers.

**Organiser:** Heat Pump Centre

**Workshop time:** 10:00 a.m. to 1:00 p.m., including a coffee break, followed by lunch.

**Agenda:** [Download pdf.](#)

# Sound Propagation Analysis

## **Description:**

Calculate and analyze sound propagation using predictive software to assess noise levels in the environment and their psychoacoustic correlations.

## **Objectives:**

- Utilize software tools to predict and analyze sound propagation and noise levels.
- Investigate correlations between sound levels and psychoacoustic responses.
- Assess cumulative environmental effects of noise from heat pumps.

## **Expected Outcomes:**

- Detailed analysis of noise propagation and its impact on the environment.
- Identification of potentially disruptive noise components, aiding in better operational management of heat pumps.
- First IBP-Outcomes based on Projects “**MENESA**” und “**PsyKart**” already exist.





SCIENCE  
PASSION  
TECHNOLOGY

# Estimation of sound propagation using a web-based 2D-tool

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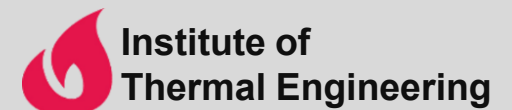
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Milano, March 24-27, 2026

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Mostra Convegno, Milano (March 24-27, 2026)



# Motivation

- Noise emissions from heat pumps are a key barrier for wide implementation
- Especially in urban living areas sound limits might restrict installation

## Current challenges:

- Detailed models are complex and not practical for quick decision-making
- Simplified approaches often neglect geometry, surroundings, and barriers

| Dayperiode   | Holiday house area     | Noise L <sub>r</sub> for dense low building area (detached houses semidetached houses and others.) | Blocks of flats Mixed living and business areas, Open land (detached houses) |
|--|------------------------|--|--|
| Working days 07 – 18<br>Saturdays 07 – 14                    | L <sub>r</sub> ≤ 40 dB | L <sub>r</sub> ≤ 45 dB   | L <sub>r</sub> ≤ 50-55 dB  |
| Working days 18 – 22<br>Saturdays 14 – 22<br>Sundays 07 – 22 | L <sub>r</sub> ≤ 35 dB | L <sub>r</sub> ≤ 40 dB   | L <sub>r</sub> ≤ 45 dB   |
| All days 22 – 07   | L <sub>r</sub> ≤ 35 dB | L <sub>r</sub> ≤ 35 dB   | L <sub>r</sub> ≤ 40 dB   |

## Objectives of the 2D-Tool

- Provide an easily accessible (“for everybody”) estimation of sound propagation (based on ISO 9613)
  - Consideration of:
    - Distance
    - Installation configuration (e.g., ground, wall)
    - Barriers and shielding effects
- ⇒ Support planning, positioning, and scenario analysis

# Approach

- Implementation based on a previous web-based interactive 2D-tool from *Danish Technological Institute*

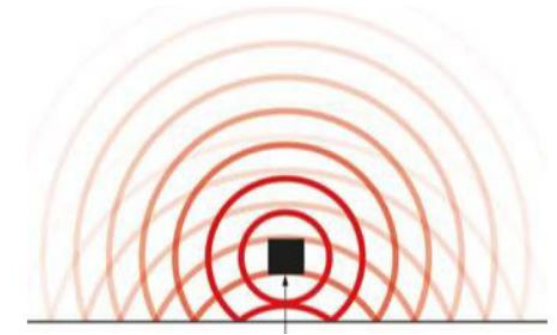
- Sound propagation based on ISO9613-2 for a hemispherical propagation

$$L_p(r, \varphi) = L_w - [20 \log_{10}(d) + 8]$$

- Considered attenuations

- **Sound shielding:** Reduction of direct sound due to insulation
- **Reflection & amplification by nearby structures:** Increased sound levels caused by building façades and confined geometries
- **Directional radiation of the outdoor unit:** Non-uniform emission depending on fan orientation and housing design
- **Ground effect (surface characteristics):** Differentiation between acoustically hard (e.g. concrete) and soft (e.g. grass) surfaces influencing absorption
- **Diffraction at barriers:** Sound propagation around obstacles (e.g. walls) when no direct line of sight exists

- Visualization of sound propagation



# Implementation

- Freely accessible web-based tool
- Use of geospatial data (OpenStreetMap) for realistic environments
- User interface in at least 4 languages (IT, FR, DE, EN)

- **User Workflow:**

- **Define source properties**

- Select sound power level
    - Specify unit characteristics

- **Set installation conditions**

- Define orientation of the outdoor unit
    - Add attenuation elements (e.g. barriers, buildings)

- **Define environment**

- Enter address
    - Place Heat Pump on map

- **Evaluate acoustic impact**

Please select a model or enter the sound power level.

Manufacturer:  Model:   dB ?

---

I want to place the heat pump's outdoor unit along an exterior wall.  I want to place the heat pump's outdoor unit in a corner of two walls. ?

I want to place the heat pump's outdoor unit at a right angle to an exterior wall.

---

More than half of the area between the outdoor unit and the boundary with the neighbor has a hard surface (e.g., tiles, concrete, or asphalt). ?

Less than half of the area between the outdoor unit and the neighbor's property line has hard surfacing.

---



No noise barrier ?

Noise barrier in front of the outdoor unit

Noise barrier on the left side

Noise barrier on the right side

Noise barrier on the left and right sides

 Back  See noise propagation on map

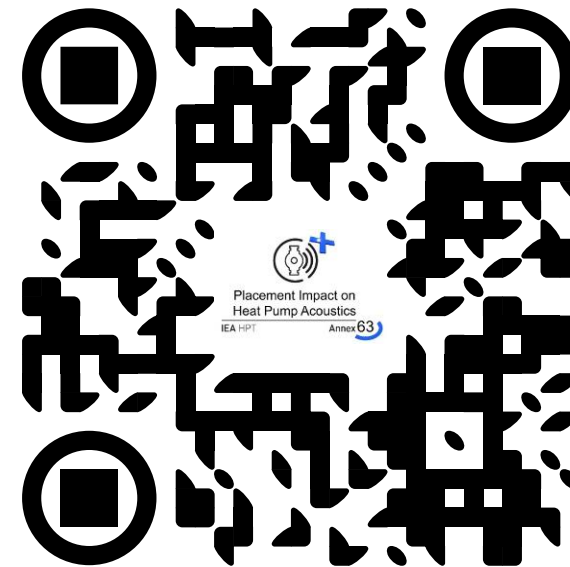




# Access the 2D-Tool!

Web application available from **May 20, 2026**

**Live presentation of the tool at the IEA Heat Pump Conference 2026 in Vienna!**



<https://heatpumpingtechnologies.org/project63/2dsp>

DISCLAIMER:

This free online tool provided by IEA HPT Annex 63 is intended solely for scientific and demonstration purposes. It provides a non-binding estimate of heat pump sound levels based on simplified models and user-provided input data. Actual sound levels may vary significantly. The online tool does not replace professional planning, measurement, or official assessment. Verification by qualified experts is expressly recommended. The online tool is provided "as is". TU Graz makes no warranties, whether expressed or implied, including, but not limited to, any implied warranties of fitness of the online tool for a particular purpose. TU Graz is not liable for any errors of the online tool and does not warrant or guarantee a specific utility of the online tool. The risk as to the quality, functionalism and performance of the online tool is with the user. In particular, TU Graz is not liable for direct or indirect damages or subsequent damages due to errors of the online tool.



# 3D Visualization

[RAARA - Residential Area Augmented Reality Acoustics](https://raara.ait.ac.at/)

<https://raara.ait.ac.at/>



Live presentation of the tool at the IEA Heat Pump Conference 2026 in Vienna!

[www.heatpumpingtechnologies.org](http://www.heatpumpingtechnologies.org)



# 3D Visualization



Live presentation of the tool at the IEA Heat Pump Conference 2026 in Vienna!

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# Annex 51 Task 6 “Psychoacoustics”

## Motivation:

- *Legislation and standards contain A-weighted levels*
- *Perception is also influenced by other quantities e.g. loudness, roughness, tonality ...*

## Aim:

- *Investigate effect of quantities other than A-weighted levels*
- *Reproducibility across multiple sites*

## Action:

- *Perform a perception experiment at different sites*
- *Problem: due to Covid only two sites were able to participate*

# Study Design

## Recordings:

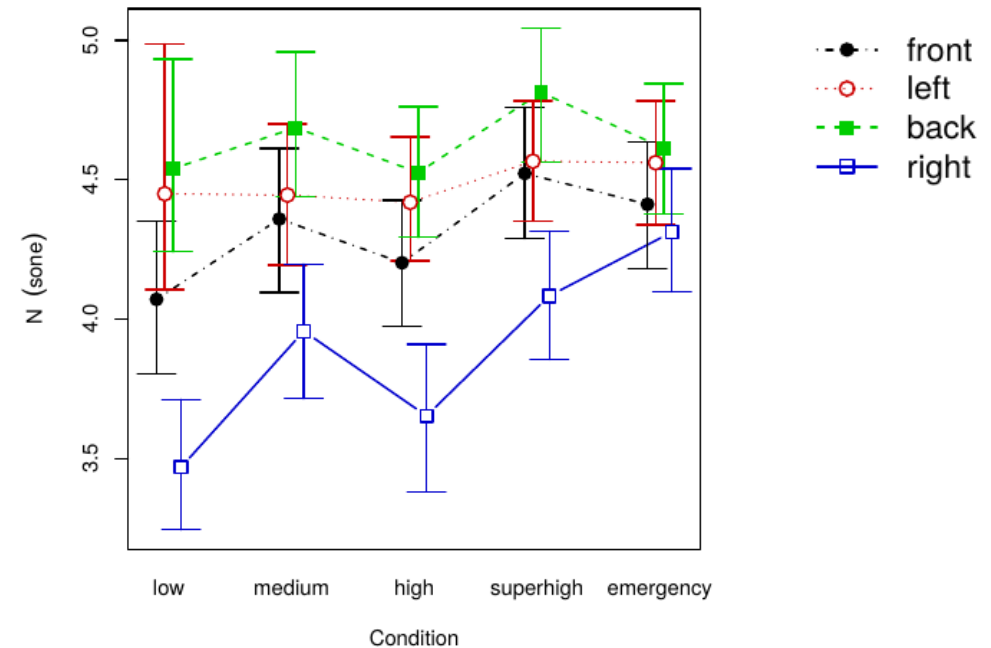
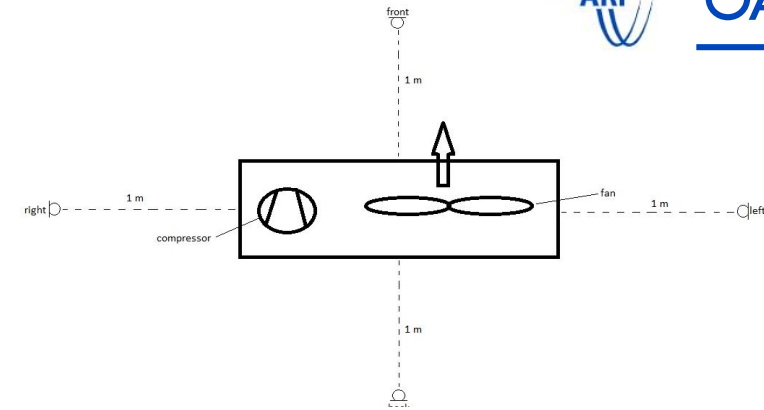
- *Air-source heatpump recorded in hemi-anechoic room*
- *5 operational modes with varying compressor and speeds*
- *4 measurement positions*

## Stimuli:

- *5 second duration*
- *equalized A-weighted level of 40 dB(A)*
- *Residual loudness variation still present*

## Study:

- *40 listeners (20 Austria, 20 Sweden)*
- *Annoyance rating*



# RESULTS

## AUT vs SWE:

- *Results highly consistent over site*

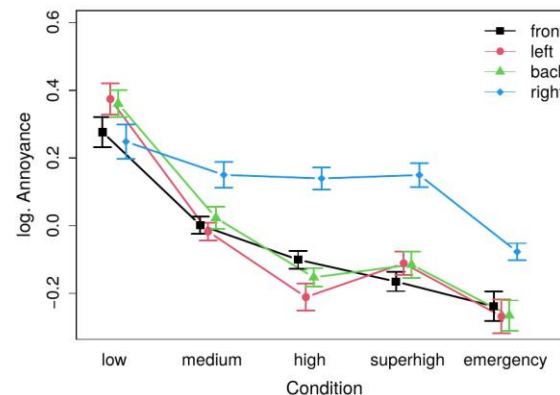
## Operation mode:

- *"low"-mode most annoying*

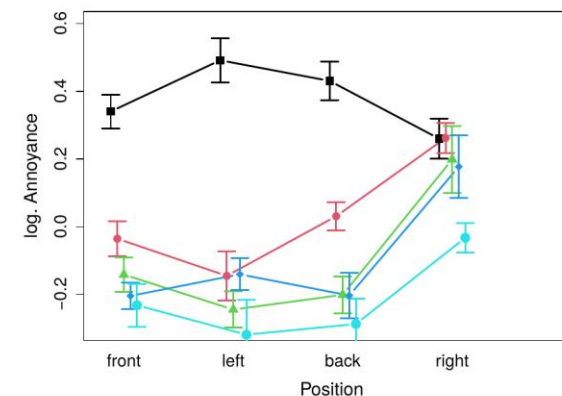
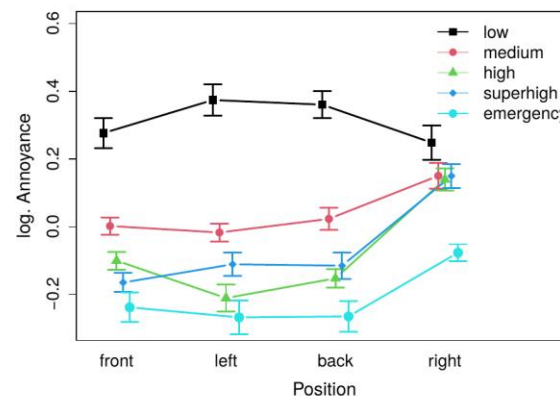
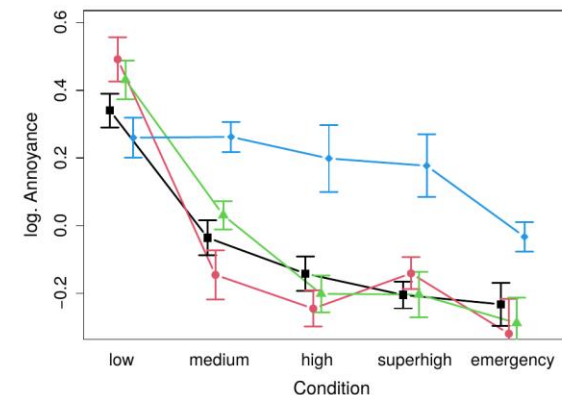
## Position:

- *Compressor side almost always most annoying*
- *Statistical interactions with mode*

Austria



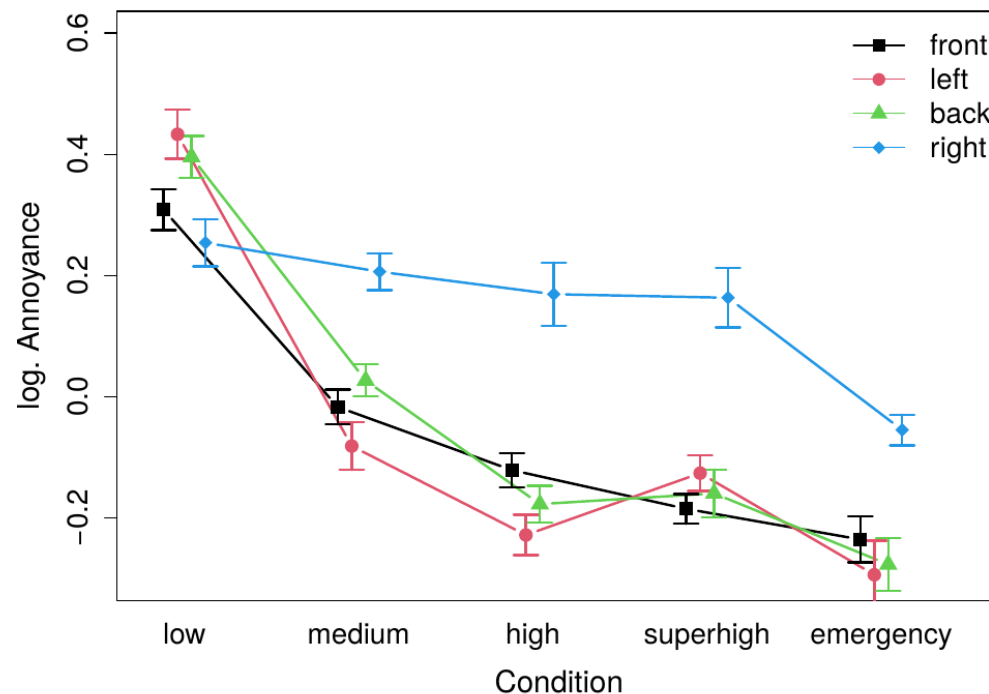
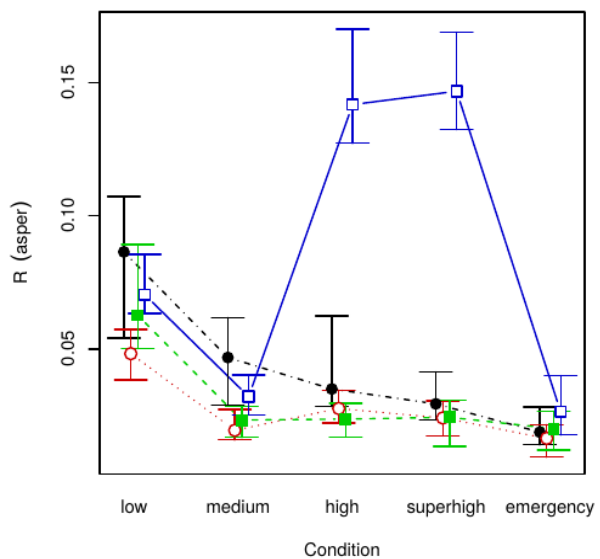
Sweden



# RESULTS

## Annoyance index:

- Regression model using acoustic features
- Step-wise addition of features
- Roughness, Loudness, Sharpness, and Tonality explained more than 90%
- Peak Roughness is the best single predictor (40%)



- front
- left
- back
- right

# SUMMARY

## Significant main effect of operation mode in perception data

- *Despite a significant interaction the effect seems consistent*
- *Directionality is potentially decreased in a realistic setting*

## Interaction between mode and direction is difficult to interpret

- *Significant main effect of direction confounded by interaction*
- *Inconsistent effects for low-condition*
- *Residual loudness variation still present*

**Annoyance ratings were explained to a high degree by the roughness, loudness and sharpness**

# Thank you for your time!



## Placement Impact on Heat Pump Acoustics

IEA HPT

Annex 63

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*... your IEA HPT Annex 63 team*