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THE 25<sup>th</sup> IIR INTERNATIONAL  
CONGRESS OF REFRIGERATION  
August 24-30 | Montréal, Québec, Canada



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# ACOUSTIC EMISSIONS AND NOISE ABATEMENT OF AIR TO WATER HEAT PUMPS // PART2

## Acoustics of Heat Pumps

*Workshop, 29.08.2019*



Acoustic Signatures  
of Heat Pumps

IEA HPT

Annex 51

Christoph Reichl, Peter Wimberger, Felix Linhardt, Johann Emhofer



# CORRELATED ACOUSTICS – VIBRATION & FLOW



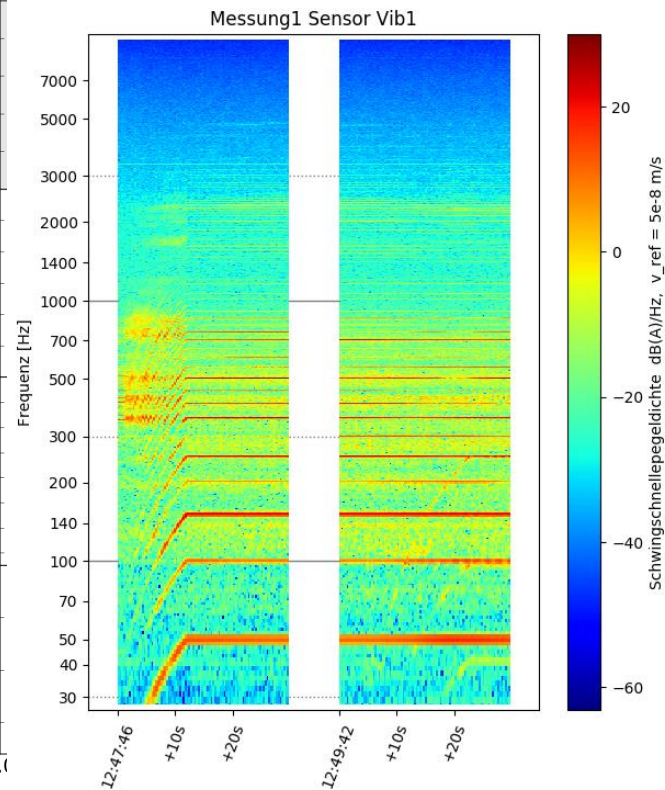
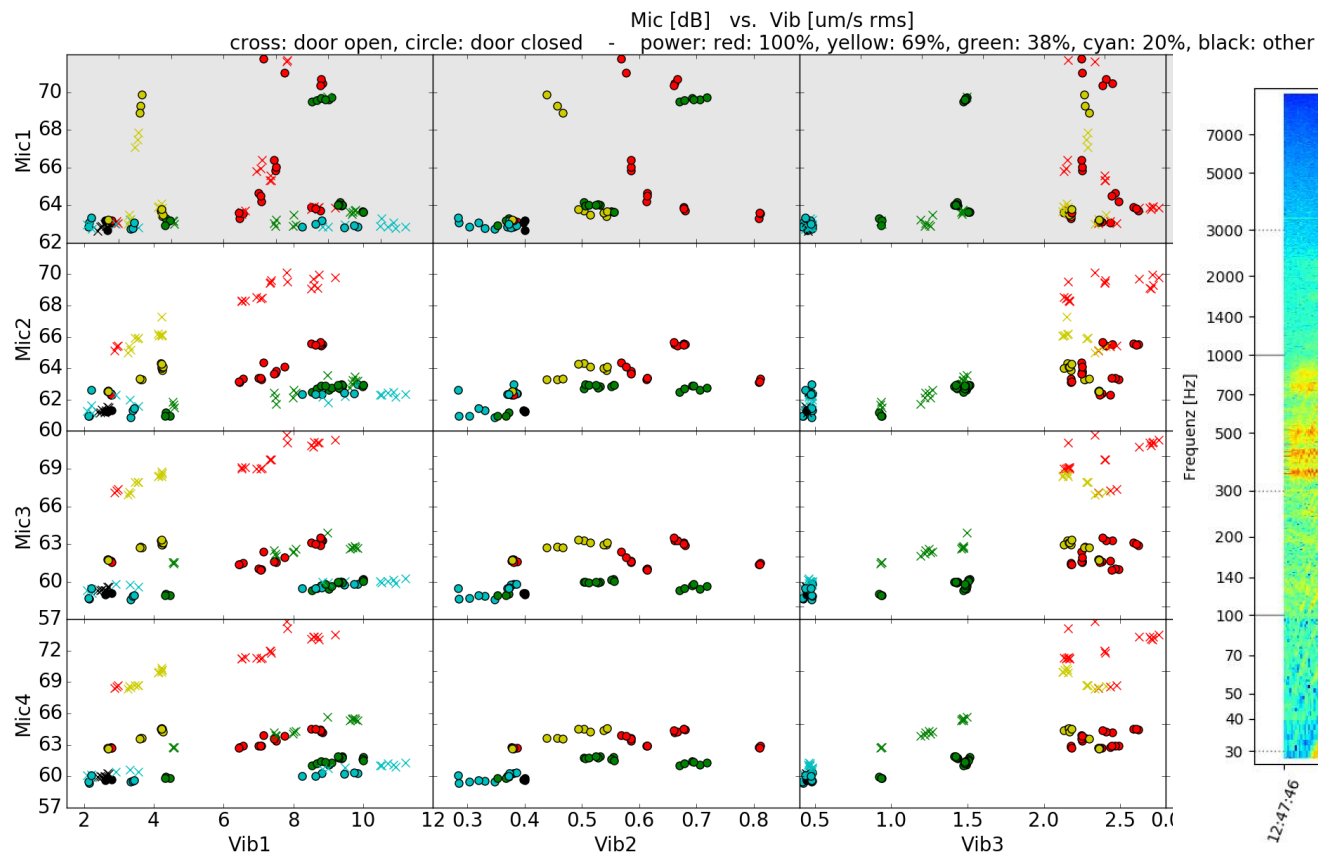
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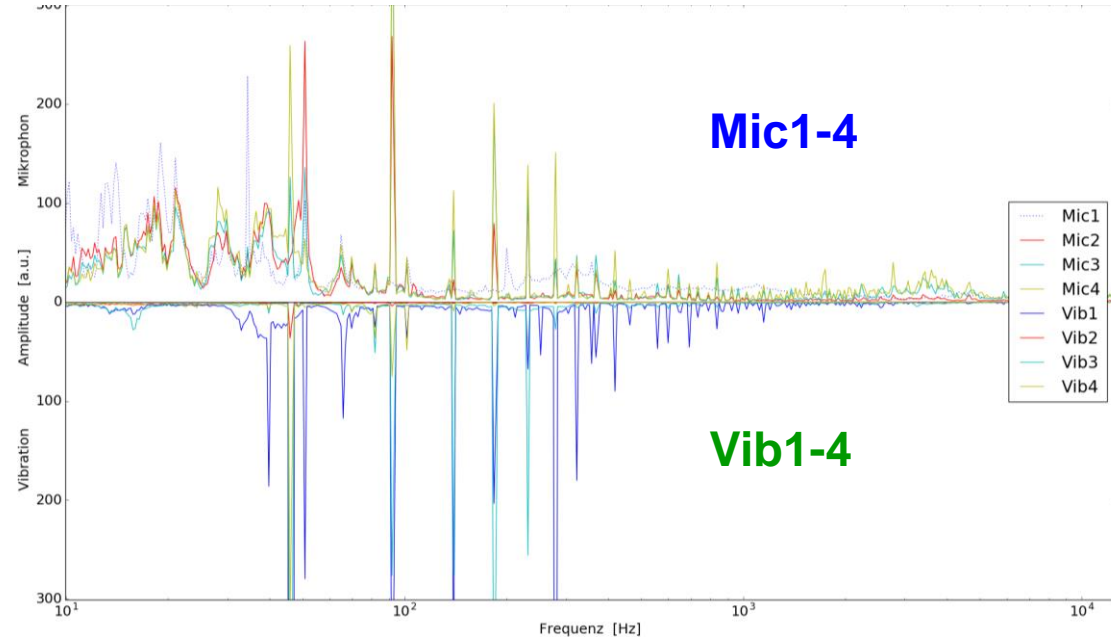
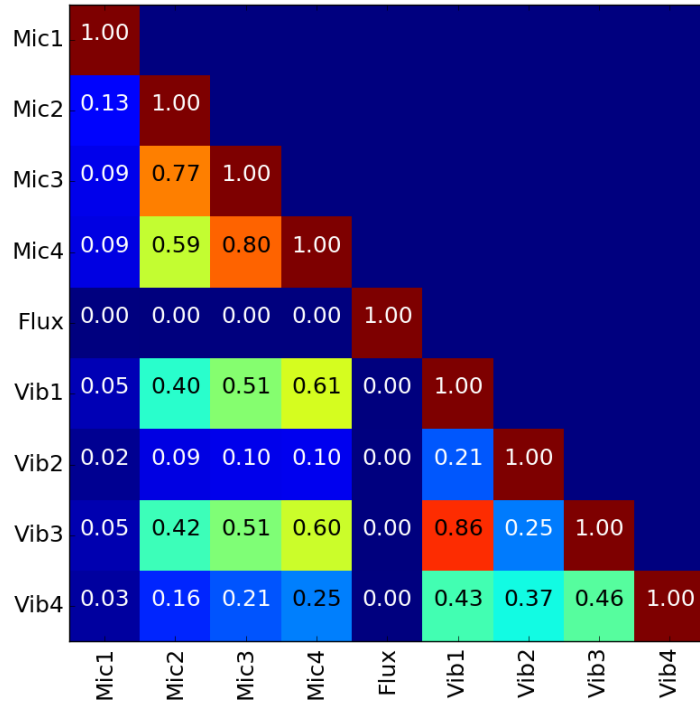
# CORRELATED ACOUSTICS – VIBRATION & FLOW



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# NUMERICAL METHODS – NOISE PROPAGATION SIMULATION



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## Immission recording at window faces



# NUMERICAL METHODS – NOISE PROPAGATION SIMULATION



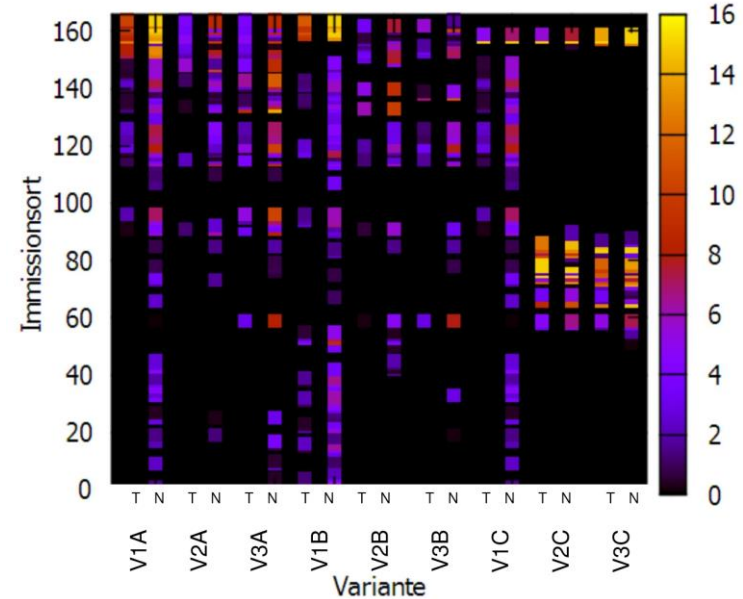
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Heat pump placement



penalty point analysis





# RESULTS

Measure		Mechanism	Influence of SPL
<b>Constructive measures</b>			
1	Compressor encapsulation	Extremely important, if compressor is in the outer unit	-
2	Insulation of compressor against structure born noise		-
2a	Insulation of compressor against airborne noise	Mounting of a compressor cover	reduction: <1 dB(A)
3	Insulation of fan against structure born noise	Reduced transmission of structure born noise to case and channels	-
4	Improvement of flow field in vicinity of fan	Diffusor	reduction: 2 dB(A)
4	Sound absorbing channel insulation	Insulation material	reduction: <4 dB(A) at maximum fan rotation
6	Angled channel deflection including additional lining	Channel deflection used as sound absorber; channel dimensions should be large; optimal sound radiation to the top	reduction: 2 dB(A)
7a	Absorption sound absorber	deflection coulisse sound absorber	reduction: 2.5 dB(A)
7b	Absorption sound absorber	deflection	reduction: 2.5 dB(A)
8	Avoidance of channel resonance	Coordination of length and cross section of channels	-
9	Guiding vanes in bends and elbows	Reduced turbulences and reduced pressure drop	-
<b>Component specific measures</b>			

<b>Component specific measures</b>			
10	Low-noise compressor	Noise reduction of source	-
11	Low-noise fan	Reduction of fan noise	reduction: 8 dB(A)
12	Sound deadening of fan blades	Reduced structure born-noise emission of the fan blades	see 11
13	Optimization of operating points of fan	Reduction of fan noise because of improved flow conditions	see 4
14	Optimization of evaporator	Reduction of pressure drop of the evaporator r	Dependent on fan characteristics (e.g. 5 dB(A) when dividing pressure drop by a factor of 2)
15	Anti-ice coatings	Delay of frosting onset; change of defrosting behavior of evaporator	No change in SPL
<b>Control measures</b>			
16	Optimization of fan rotation speed	Simple fan rotation speed reduction using different wiring or use of resistances	Dependent on fan characteristics (e.g.: 5 dB(A) when reducing fan speed by 100 rpm)
17	Optimization of control	Less on/off switching operations and reduced operating time in the night; part load operation in the night.	Using A2W35 und night setback (12h): 10 dB(A), day: +4.5 dB(A)
18	Defrosting strategies	Changed frost accumulation behavior	Noise level of defrosting smaller than standard noise level

# DOWNLOAD OF FINAL REPORT OF SILENTAIRHP



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Annex 51 Home Activities Contact Participants Team site

## ANNEX 51 Acoustic Signatures of Heat Pumps

Reduction of acoustic emissions is important to further increase the acceptance of heat pumps as air-to-water, water-to-air, air-to-air and brine-to-water (ground source) units. To increase this acceptance and minimize noise annoyance more focus has to be put on the acoustics emissions at steady state and transient behaviour of acoustic signatures during different operating conditions (e.g. icing, de-frosting, capacity control, cooling mode).

**The primary aim** with Annex 51 is to further increase the acceptance of heat pumps (as air-to-water, water-to-air, air-to-air and brine-to-water units) for comfort purpose with respect to the noise and vibration emissions.

**A second focus** is placed on increasing knowledge at different levels (manufacturers, acoustic consultants, installers, legislators). To reach this goal, first different reasons to reduce sound emissions depending on countries (legislation), locations and applications have to be gathered and understood. The main influencing factors to the acoustic signature of these units will be identified. Collecting and combining research results in these fields on the different implementation levels (component, unit and application) will finally lead to directions for improved components, units and control strategies including guidelines, as well as training and inputs to future standards. The aim is to gather the knowledge and expertise of the participants on the different levels in order to forward this knowledge and establish recommendations and advices.

<https://heatpumpingtechnologies.org/annex51/>

The official final report will be linked there ...



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# SUMMARY AND OUTLOOK

## EXPERIMENTAL METHODS

Dome, Beamforming, Correlations

## NUMERICAL METHODS

Noise Propagation, 1D heat pump models

## RESULTS

list of measures, mechanisms and  
influence on sound power level

## DOWNLOAD

full report via the Annex 51 website soon





# ACKNOWLEDGEMENTS



The work on “IEA HPT Annex 51” is financially supported within the framework of the “IEA Research Cooperation”, the project "SilentAirHP" within the framework of the "Klima Energy Fonds" on behalf of the “Austrian Federal Ministry for Transport, Innovation and Technology”.

 Federal Ministry  
Republic of Austria  
Transport, Innovation  
and Technology



FFG



IEA RESEARCH  
COOPERATION





# THANK YOU!



Christoph Reichl  
*for the SilentAirHP team*





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## Acoustics of Heat Pumps

*Workshop, August, 29th 2019*  
*Montréal, Québec, Canada*

*8:30 – 10:10*



# WORKSHOP PROGRAM



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- Acoustic Signatures of Heat Pumps in the framework of the International, Energy Agency Technology Collaboration Programme on Heat Pumping Technologies (IEA HPT TCP)
- Acoustic Regulations of Heat Pumps
- 1D modelling of heat pumps including acoustics
- Simultaneous energy efficiency and acoustic evaluation of heat pump systems using dynamic simulation models
- Acoustic Emissions and Noise Abatement of Air to Water Heat Pumps
- Testing campaign on the energetical and acoustical behaviour of a heat pump
- Heat pump noise – operation dependence and seasonal averaging
- Panel Discussion



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# THANK YOU!

The „Acoustic of Heat Pumps“ Workshop team

