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EFFECTIVE SOUND IMAGING

# CONTENT

# QUALITY ASPECTS OF SOUND IMAGING

# WHY
# THE DIAMETER OF
# THE MEASUREMENT SURFACE
# MATTERS

QUALITY ASPECTS OF SOUND IMAGING

# APPEARANCE OF SOUND SOURCES
# IN ACOUSTIC IMAGES


**RED** is strong, **BLUE** is e.g. 6dB less.

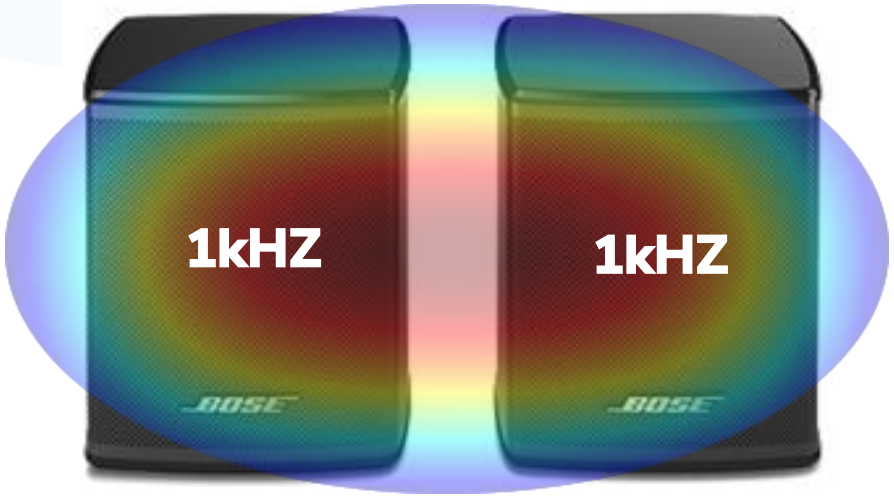
The **image** of a point-like sound source is represented by a **radially distributed source** with declining strength away from the source.

# APPEARANCE OF SOUND SOURCES
## IN ACOUSTIC IMAGES


The **lower the frequency** of the sound source, the **wider the sound source** appears and therefore the **harder** it is to **spatially resolve** the source.

**QUALITY ASPECTS OF SOUND IMAGING**

# APPEARANCE OF SOUND SOURCES
## IN ACOUSTIC IMAGES

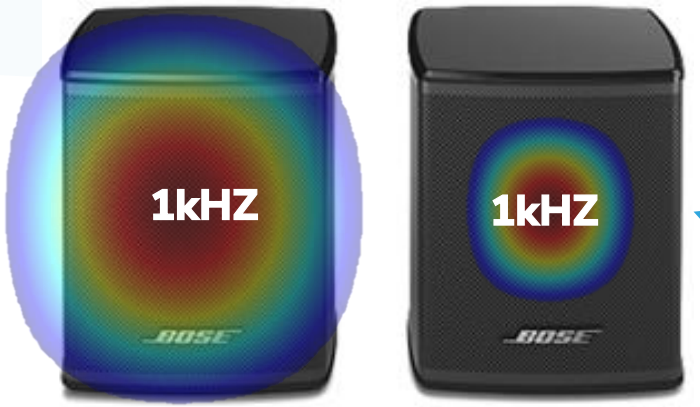



**CHALLENGE**

As two sources with the same frequency **move closer** together, their individual **heat maps start to add up**.

**QUALITY ASPECTS OF SOUND IMAGING**

# APPEARANCE OF SOUND SOURCES
# IN ACOUSTIC IMAGES




## SOLUTION

Measurement instruments with microphones distributed on **larger surfaces** are capable of better resolving **sound sources** at **low frequencies**.

**QUALITY ASPECTS OF SOUND IMAGING**

# REAL LIFE EXAMPLE AT 400Hz

**BENCHMARK | SEVEN BEL SOUND SCANNER P132 VS. CAE BIONIC M-112**

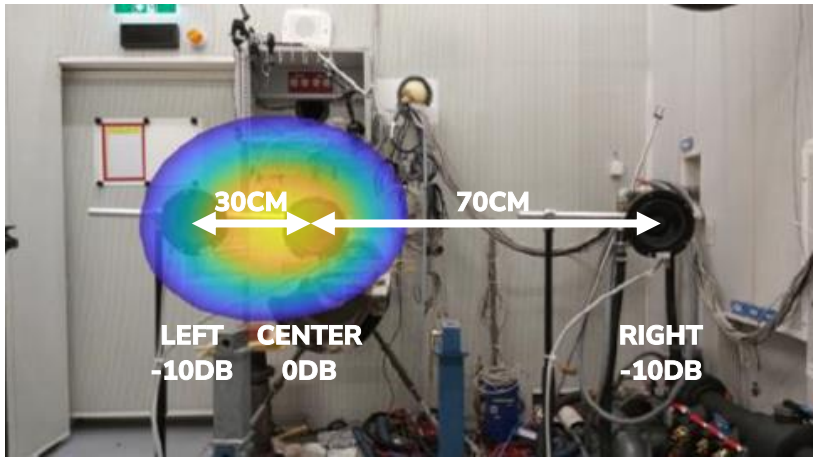
**BEAMFORMING CAMERA**
**shows lower spatial resolution**
**vertical offset**

## CHALLENGE

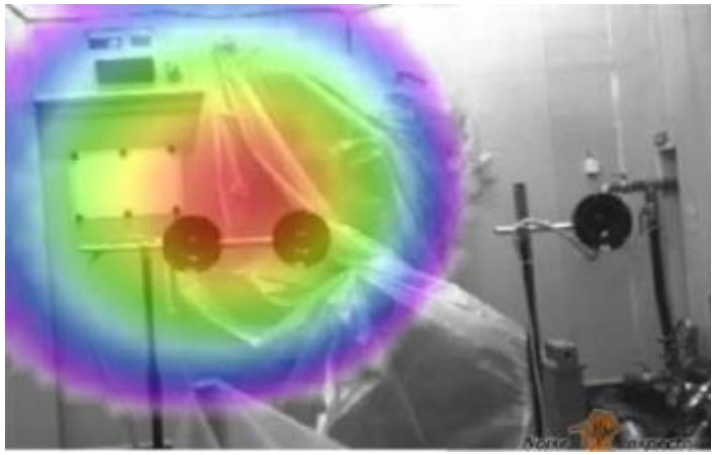
Separate individual sources at
**LOW FREQUENCY**

## SETTING

- Frequency: **400Hz +/- 11Hz**
- Dynamic Range: 1dB




**Sound Scanner P132**
⌀ **132cm,** 250Hz – 10.5kHz
Coherence Scanning Holography



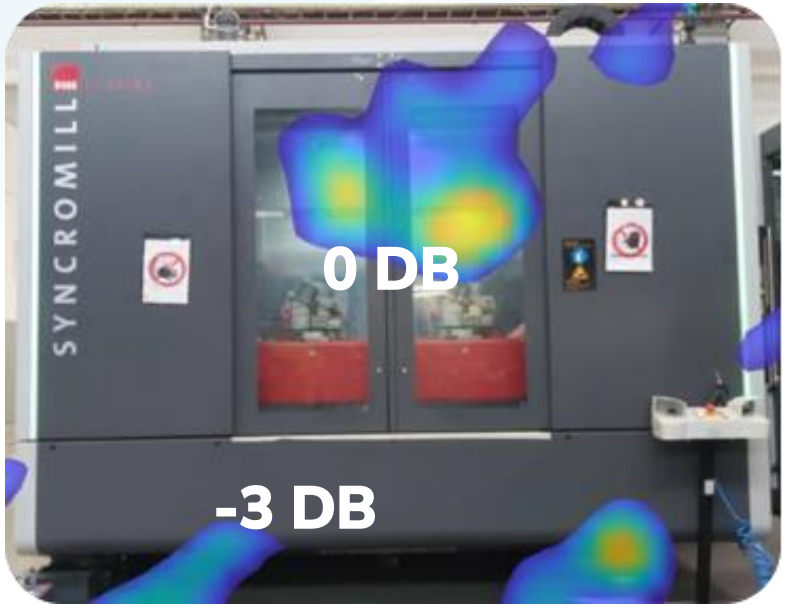
**CAE BIONIC M-112**
⌀ **100cm**, 250Hz – 20kHz
Beamforming

**HOW 30CM MORE IN DIAMETER MAKES A DIFFERENCE**

# WHY THE NUMBER OF DISTRIBUTED MICROPHONES MATTER

QUALITY ASPECTS OF SOUND IMAGING

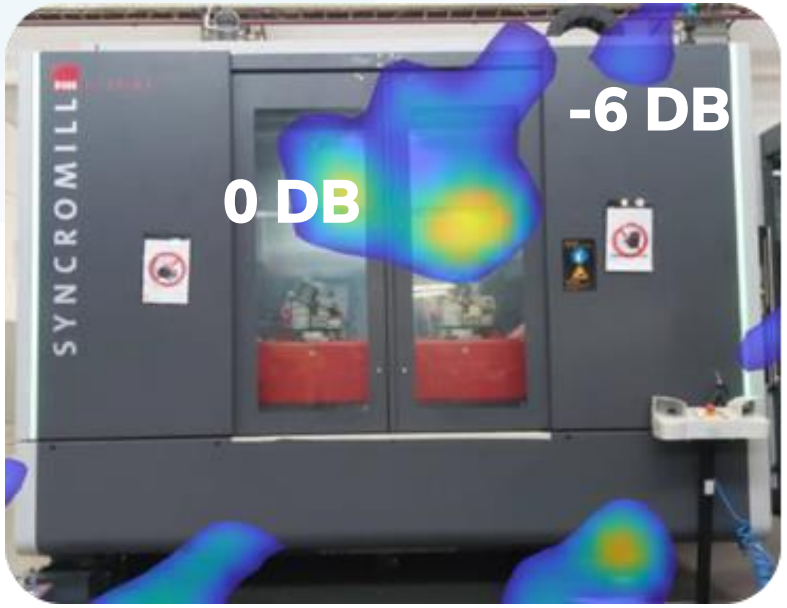
# APPEARANCE OF SOUND SOURCES
## WITH DIFFERENT STRENGTH




To detect sound sources with **lower strength** in an acoustic image, we gradually **increase the dynamic range (DNR)** until the sources become visible.

**QUALITY ASPECTS OF SOUND IMAGING**

# APPEARANCE OF SOUND SOURCES
## WITH DIFFERENT STRENGTH




The DNR is the difference between the **maximum and minimum sound pressure** level shown in the acoustic image.

**-6DB MEANS 50% LESS SOUND PRESSURE LEVEL**

**QUALITY ASPECTS OF SOUND IMAGING**

# APPEARANCE OF SOUND SOURCES
# WITH DIFFERENT STRENGTH


ARTIFACT OR GHOST IMAGE

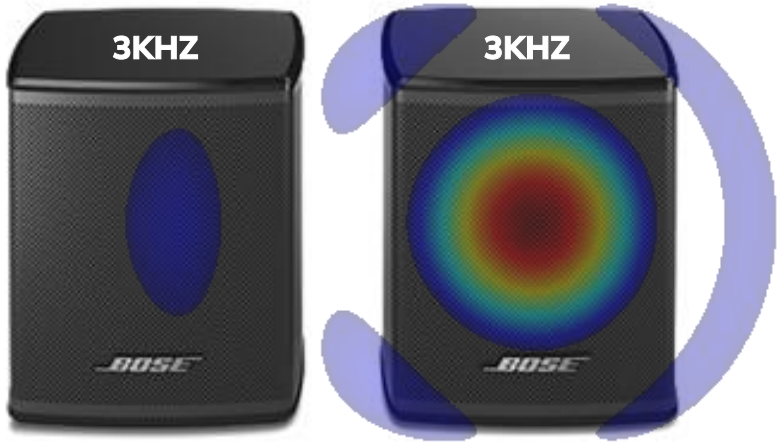
As we **increase the DNR,** at some stage **ARTIFACTS** appear, which are disturbances in an acoustic image or sound caused by a **limitation in the hardware or software**.

**QUALITY ASPECTS OF SOUND IMAGING**

# APPEARANCE OF SOUND SOURCES WITH DIFFERENT STRENGTH

HIGH MIC COUNT


LOW MIC COUNT




A configuration with a **LOW microphone density fails** at lower DNR values to display sound sources with **correct levels of strength**.

**QUALITY ASPECTS OF SOUND IMAGING**

# REAL LIFE EXAMPLE AT HIGH DNR

**BENCHMARK | SEVEN BEL SOUND SCANNER P132 VS. CAE BIONIC M-112**

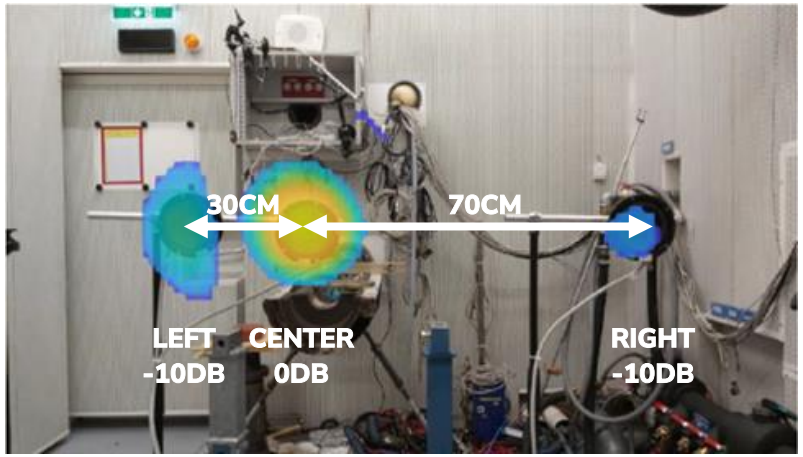
**BEAMFORMING Camera cannot resolve left and right low noise speakers.**

## CHALLENGE

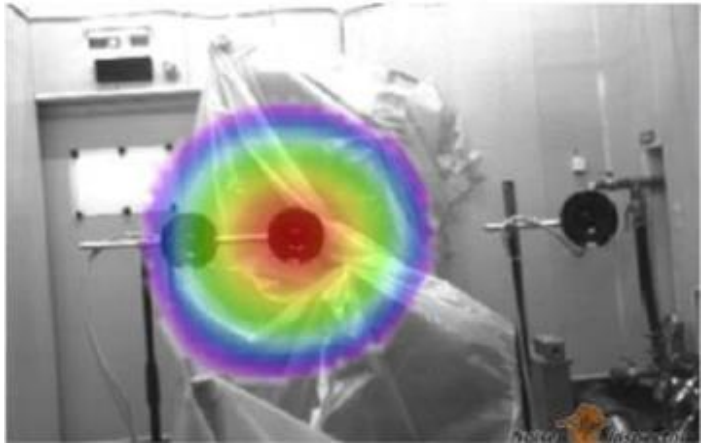
Locate individual sources at
**HIGH DYNAMIC RANGE**

## SETTING

- Frequency: 2000Hz +/- 60Hz
- **Dynamic Range: 15dB**




**Sound Scanner P132**
**+400 (virtual) microphones,** 250Hz – 10.5kHz
Coherence Scanning Holography



**CAE BIONIC M-112**
**112 microphones**, 250Hz – 20kHz
Beamforming

## HOW 300 ADDITIONAL MICROPHONES MAKE A DIFFERENCE

# TRADITIONAL ACOUSTIC CAMERAS

## CONCEPTS & LIMITATIONS

# TRADITIONAL ACOUSTIC CAMERAS

## ALL BASED ON BEAMFORMING

### LAB-TYPE INSTRUMENT | frequency >250Hz

**Array** ⌀ 0.5m to 1.5m; 60-250 mics, **Signal Processing Unit**, **Laptop** for controlling, post-processing and visualizing the measurements; **all mains powered.**

### KNOWN LIMITATIONS

- Reduced mobility
- Long setup time (15 minutes and up)
- Expensive as realization of large arrays requires a high microphone count.

# TRADITIONAL ACOUSTIC CAMERAS

**ALL BASED ON BEAMFORMING**


### KNOWN LIMITATIONS

- Weighs more than 2kg
- For special sound events only (transient, broadband, high freq)
- Not for in-depth analysis (fixed frequency settings during recording; analysis may need data transfer to separate laptop)

### MOBILE ACOUSTIC CAMERA | Frequency >2kHz

**Array** ⌀ 30cm; 40–70 mics**, integrated device** (array, **signal processing unit**, **display** for controlling and visualizing the measurements, battery powered with a lifetime of 2 hours.

# MICROPHONE ARRAY BEAMFORMING

## THE BASIC IDEA

Sound waves travelling through air hit certain spatial positions at different points in time depending on the angle of incidence.

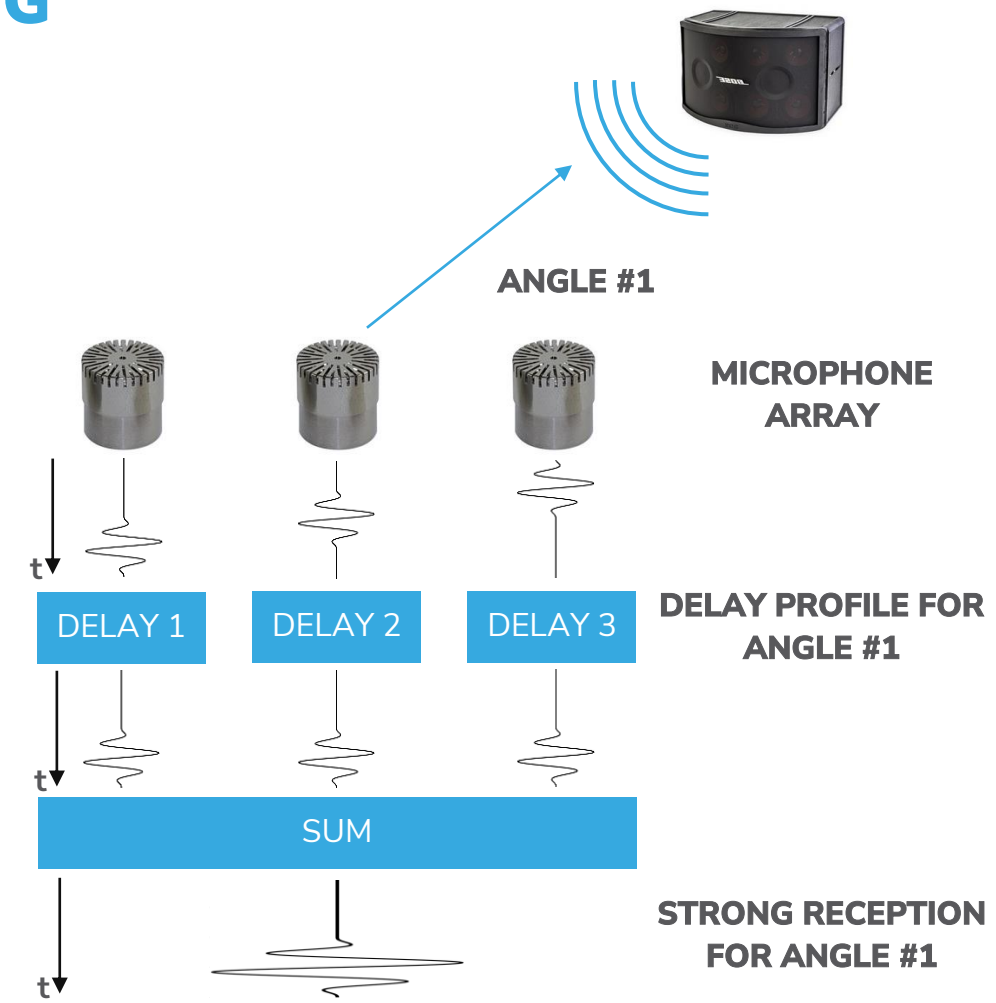
Humans identify the direction of a sound event by sensing the temporal difference of when the sound wave impinges on the left and right ear.

## THE ALGORITHM

When sensing the strength of a sound event from a certain direction, each of the microphone signals is delayed according to a fixed pattern.

When a sound event impinges on the microphones exactly from the direction that the delay profile is configured for, all of the signals perfectly add up.

For any other direction with a corresponding delay pattern, the microphone signals do not add up well which is an indication of only little or no sound coming from that particular direction.




**BEAMFORMING IS A METHOD OF SPATIALLY FILTERING INCIDENT SOUND WAVES BY DELAYING AND SUMMING MULTIPLE MICROPHONE SIGNALS FOR EACH DIRECTION OF INTEREST.**

# COHERENCE SCANNING HOLOGRAPHY (CSH)

## THE ALGORITHM

### STEP 1

The audio signal of the moving microphone is propagated back in time to a point in the reconstruction plane.

Based on the motion of the moving microphone, the audio signal appears to have been emitted from that point.

The Doppler shift is fully compensated for a point where a sound source is actually located. For any other points away from the point source, an additional Doppler shift is induced in the backpropagated audio signal.

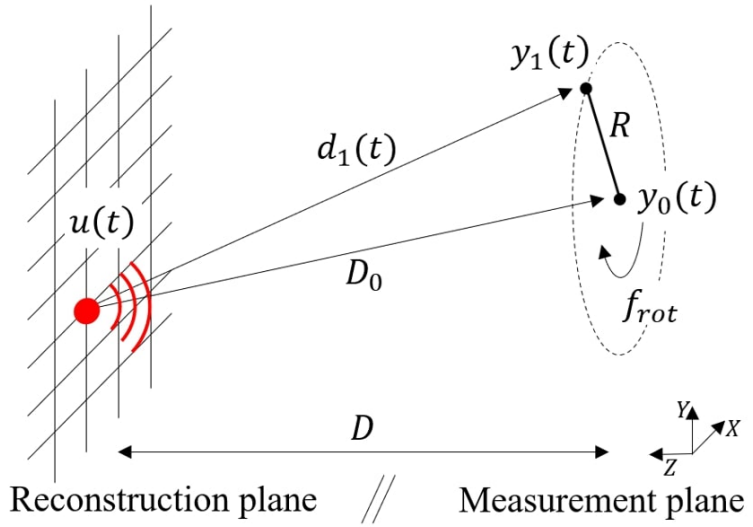
### STEP 2

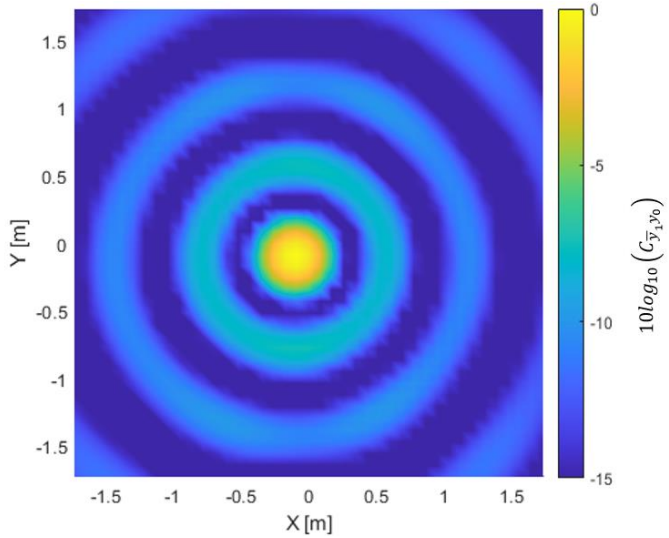
We compute the coherence (measure of similarity) between the two signals coming from the moving and reference microphones.

We get a strong coherence value for points where a sound source is actually located. A weak coherence value is reported for points where there is no or little sound emission happening.

### STEP 3

A heatmap is computed from this measure for the entire reconstruction plane. The heatmap is overlaid onto an optical image of the measurement scene.



# THE SOUND SCANNER
# THE GAME-CHANGING ACOUSTIC CAMERA

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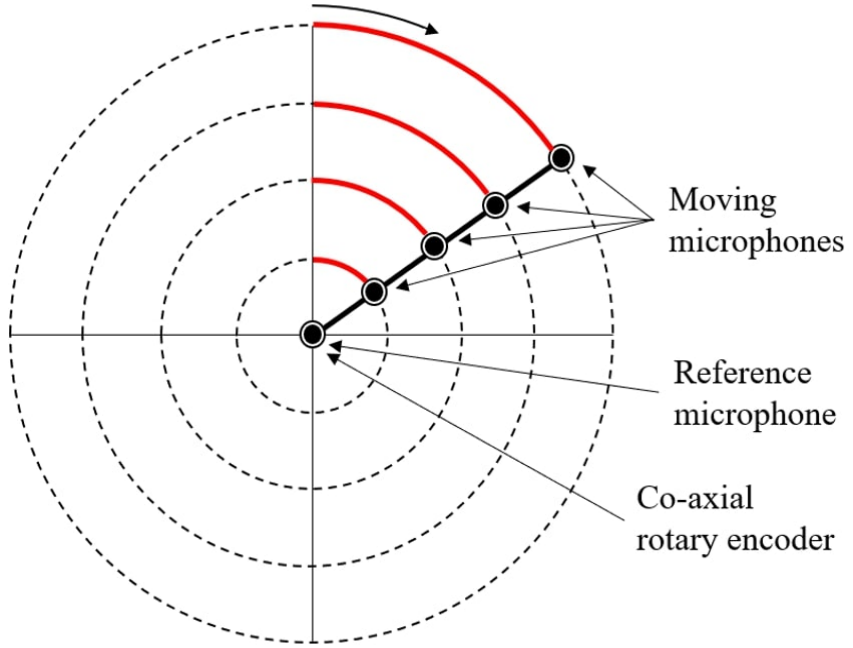
# COHERENCE SCANNING HOLOGRAPHY
## THE SENSING CONCEPT

>> **SCANNING THE SOUND FIELD** with moving microphones allows for a granular sampling of the sound field even at physically non-realizable positions.

>> **DOPPLER FREQUENCY SHIFT** is baked into the audio data acquired over a full revolution of the moving microphones.

>> **A STATIONARY MICROPHONE** at the center of the scanning area is used as a reference and is free from Doppler frequency shift.

>> **A MAGNETIC ROTARY ENCODER** measures the angular position of the moving microphones.




**BASED ON AUDIO DATA CAPTURED WITH MOVING MICROPHONES**

# THE SCANNING TECHNOLOGY
## OFFSETS BEAMFORMING CONSTRAINTS

**Lower manufacturing cost** through less hardware complexity.

**Better performance** in terms of dynamic range and localization accuracy.

**Flexible concept** also for extra large diameter of measurement surface for low frequency measurements.


**BASED ON AUDIO DATA CAPTURED WITH MOVING MICROPHONES**

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# SOUND SCANNER CONCEPT



**WIRELESS CONNECTION** FOR FAST SETUP TIME

**BATTERY POWERED** HARDWARE FOR 100% POWER AUTONOMY

**LIGHTWEIGHT DESIGN** FOR SUPERIOR MOBILITY

**CLOUD POWER** DELIVERING COMPREHENSIVE RESULTS OUT OF THE BOX

**MOBILE DEVICE TECHNOLOGY** FOR SEAMLESS DATA SHARING

# MEASUREMENT PROCESS

1 ROTATE SENSOR & CAPTURE AUDIO DATA

2 DATA TRANSFER TO MOBILE DEVICE AND CLOUD

3 ACOUSTIC IMAGE PROCESSING IN THE CLOUD

4 VISUALIZATION AND ANALYSIS OF RESULTS

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# ACOUSTIC IMAGE ANALYSIS

## STATIONARY EVENTS - SELECTION OF FREQUENCY BANDS

### BROADBAND ANALYSIS

- Isolate the main sources contributing to the broadband sound pressure level by controlling the DNR.
- Use the DNR to assess the importance of sources for noise control measures.

### NARROW-BAND ANALYSIS

- Zoom-in on dominant frequency bands and isolate the single source of interest.
- Combined information on frequency and source location helps understanding physical properties of structures and components.

# ACOUSTIC IMAGE ANALYSIS

## TRANSIENT EVENTS - LEVERAGING THE SPECTROGRAM

### SPECTROGRAM – THE BIG PICTURE

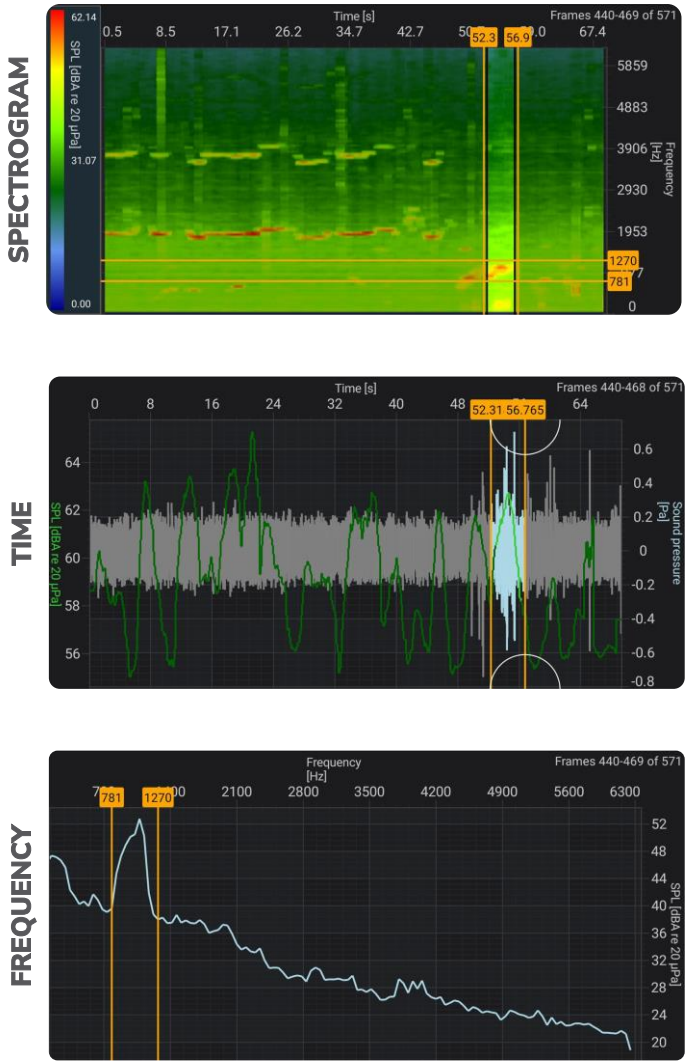
- Quickly identify abnormal sound events by looking at the time/frequency representation of the audio signal.
- Embrace the sound event of interest using the time and frequency callipers along with AVERAGING feature.

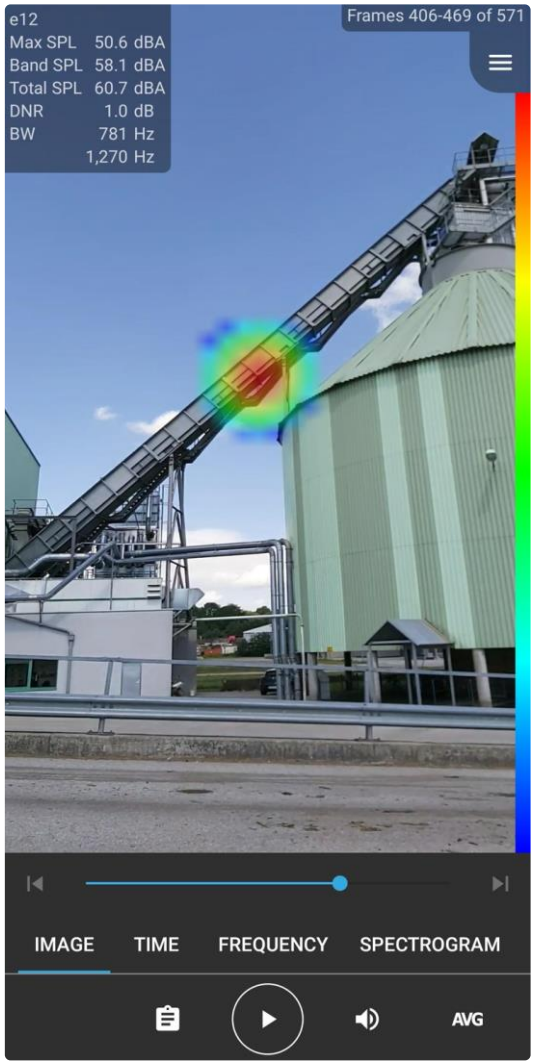
### TIME/FREQUENCY VIEW

Comfortably check time and frequency properties of the selected spectrogram section in dedicated time and frequency domain views.

### WHAT YOU HEAR IS WHAT YOU SEE

Play back the filtered audio signal to get instant feedback on what the acoustic image “sound” like.



# SOUND SCANNER PRICING MODEL

**Achieve the best localization accuracy,** even at low frequencies.

Generate an acoustic image, **in just 3 minutes.**

**Wireless, battery-powered and lightweight** for ultimate mobility.

| | |
|---|---|
| Sound Scanner Kit (P132, tablet & accessories included) | **€ 5.490,--** |
| *Additional Sensor (P12, P50, P254)* | *€ 4.490,--* |
| *Private Cloud Kit* | *€ 3.990,--* |
| *Software – Basic Package Annual software licence)* | *€ 490, per year* |
| *Software – Pro Package (Annual software licence)* | *€ 990, per year* |
| *Software – Advanced Package (Annual software licence)* | *€ 1.490, per year* |

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# REVIEW
# KEY ADVANTAGES

# SOUND SCANNER
## KEY ADVANTAGE PERFORMANCE

| | |
|---|---|
| **FREQUENCY RANGE:** | **125Hz - 44kHz** |
| **DYNAMIC RANGE:** | **up to 13dB** |
| **MIN EVENT DURATION:** | **> 125msec** |
| **MICROPHONE POSITIONS:** | **400+** |
| **MAX SURFACE DIAMETER:** | **254cm** |


**PERFORMANCE ◦ USABILITY ◦ MODULARITY ◦ MOBILITY**

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# SOUND SCANNER
## KEY ADVANTAGE USABILITY

**WIRELESS CONNECTION FOR FAST SETUP TIME**

01
10

**CLOUD POWER DELIVERS RESULTS QUICKLY WITH SUPERIOR OUT OF THE BOX IMAGE QUALITY**

**NO TRAINING NECESSARY THROUGH INTUITIVE MOBILE DEVICE TECHNOLOGY**


**PERFORMANCE ◦ USABILITY ◦ MODULARITY ◦ MOBILITY**

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# SOUND SCANNER
# KEY ADVANTAGE MODULARITY

>> **MAJOR COST SAVINGS** as users have one measurement system for ultrasound and audible domain.

>> **SMALL UPFRONT INVESTMENT** for e.g. only one camera system, add further sensors for higher or lower frequency band on demand.

>> **ONE SYSTEM AND FUNCTIONALITY** for all available sensor types.

**PERFORMANCE ◦ USABILITY ◦ MODULARITY ◦ MOBILITY**

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# SOUND SCANNER
# KEY ADVANTAGE MOBILITY

**BATTERY POWERED** HARDWARE FOR 100% POWER AUTONOMY

**LIGHTWEIGHT DESIGN** FOR EASY HANDLING IN THE FIELD

**HANDY CARRYING CASE** FOR CONVENIENT HANDLING & SHIPPING

**PERFORMANCE ◦ USABILITY ◦ MODULARITY ◦ MOBILITY**

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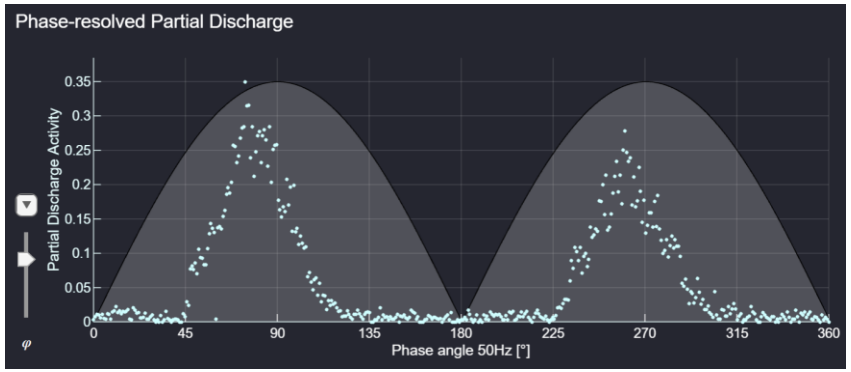
# ENERGY APPLICATIONS

# LOCALIZATION OF PARTAL DISCHARGE

**Task**
Localize suspicious sound coming from high voltage insulator. Suspicious sound can be a precursor of self-destruction. Maintenance engineer cannot get closer due to danger of flashover.

**Measurement**
Sound Scanner P50 at a distance of 4m facing isolator.

**Result**
Partial discharge on isolator precisely located. Shutdown initiated and repair work scheduled.

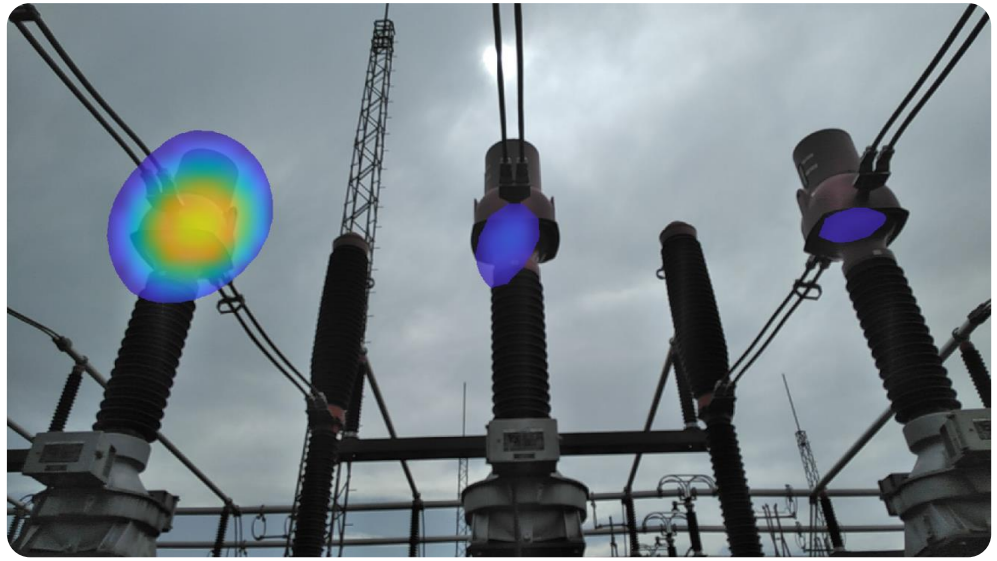


# SUSPICIOUS SOUND EMISSIONS FROM HIGH VOLTAGE INSULATORS

**Task**
Localize suspicious sound coming from high voltage insulators. Suspicious sound can be a precursor of self-destruction. Maintenance engineer cannot get closer due to danger of flashover.

**Measurement**
Sound Scanner P50 at a distance of 4m facing sources of interest.

**Result**
Sound source is left transformer on top of insulator and cause is linked to magnetic core vibrations. No further action required.



# SOUND EMISSIONS FROM A TRANSFORMER

**Task**
Locate suspicious sound emissions from a transformer. Identification of anomalies and distinction between mechanical or partial discharge sound events help engineers to plan maintenance tasks ahead of time.

**Measurement**
Sound Scanner P12 and P50 at a distance of 6m facing the high voltage insulator.

**Result**
Sound emissions verified as being purely mechanical. Inspection during regular maintenance interval showed that lifting ring was not removed after installation and got lose over time.
→ Danger of ring falling down onto critical measurement instrumentation on top of the transformer housing.


# NOISE POLLUTION FROM TRANSFORMERS

**Task**
Localize subtle metal-to-metal clatter causing noise pollution in residential area.

**Measurement**
Sound Scanner P132 at a distance of 10m facing transformer.

**Result**
Lose metal plate clearly visible in the center of the image along with cooling fan sound.

# DAMAGE DETECTION ON ROTOR BLADES

**Task**
Localize abnormal hissing sound events coming from a rotor blade potentially caused by delamination of the wing structure. Monitoring the time evolution of sound emission levels helps scheduling maintenance events.

**Measurement**
Sound Scanner P50 at a distance of 150m facing the rotor blade.

**Result**
Rotor blade area causing high frequency sound emissions precisely located. Location and wing number noted for visual drone inspection (standstill required).

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# AUTOMOTIVE APPLICATIONS

# SOUND EMISSIONS FROM ENGINE COMPONENTS

**Task**
Fine-tuning of a simulation model of a gearbox cover based on precise measurement data from sound source localization.

**Measurement**
Motorcycle on a roller dyno at 50kph and full throttle, Sound Scanner P132 at a distance of 1m focusing on gearbox cover.

**Result**
Dominant sound emission from the right half of the gearbox cover at 2,45kHz and 4,9kHz.

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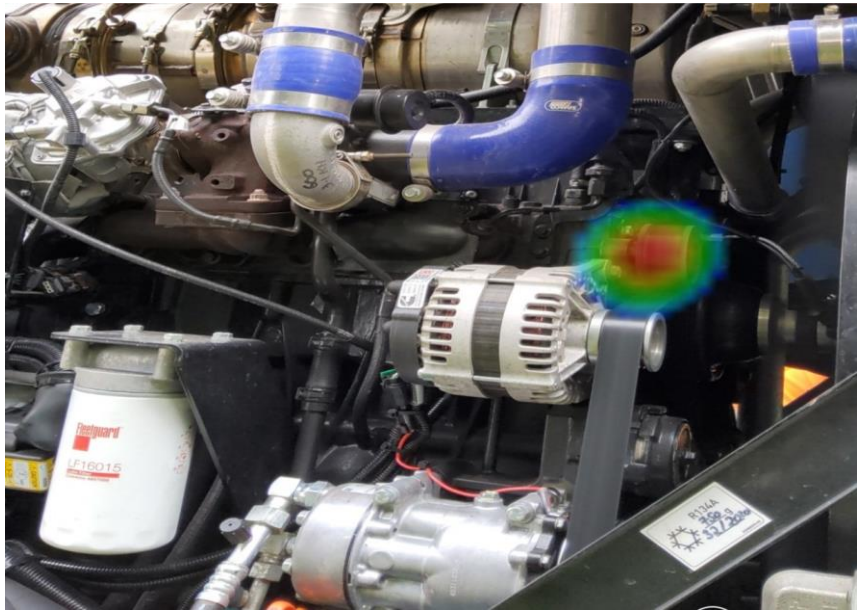
# SQUEAKING NOISE FROM THE ENGINE BAY

**Task**
Localisation of intermittent squeaking sound coming from the engine bay of a construction vehicle.

**Measurement**
Construction vehicle in a stationary operating condition, Sound Scanner P132 at a distance 0,75m focussing on the engine bay.

**Result**
Replacement of pulley.

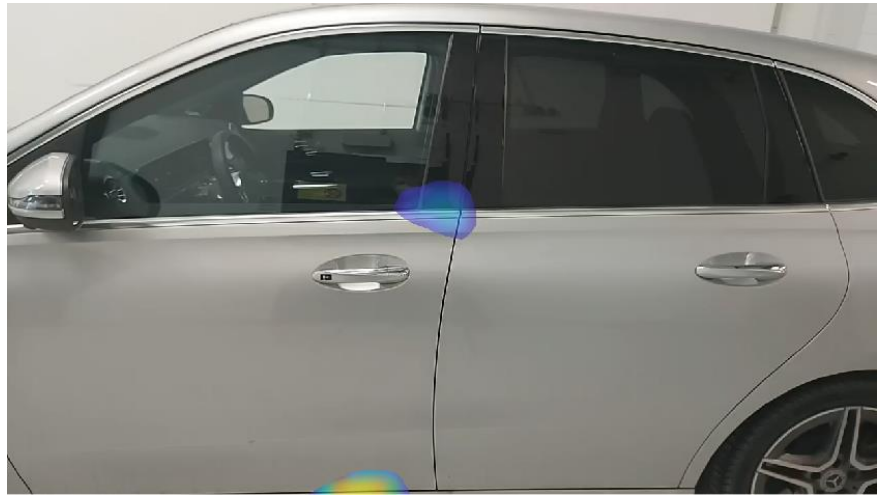


# DETECTION OF CABIN LEAKAGES

**Task**
Localisation of leakages in insulations of a car cabin.

**Measurement**
Ultrasound speaker operating at a frequency of 40kHz, Sound Scanner P12 at a distance of 1m focussing on the side of the vehicle.

**Result**
Irregular distribution of surface pressure in the area of window and door sealings.

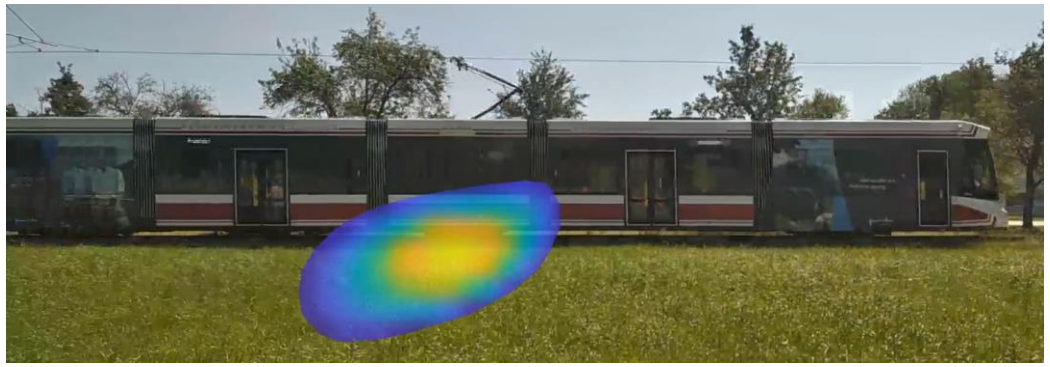


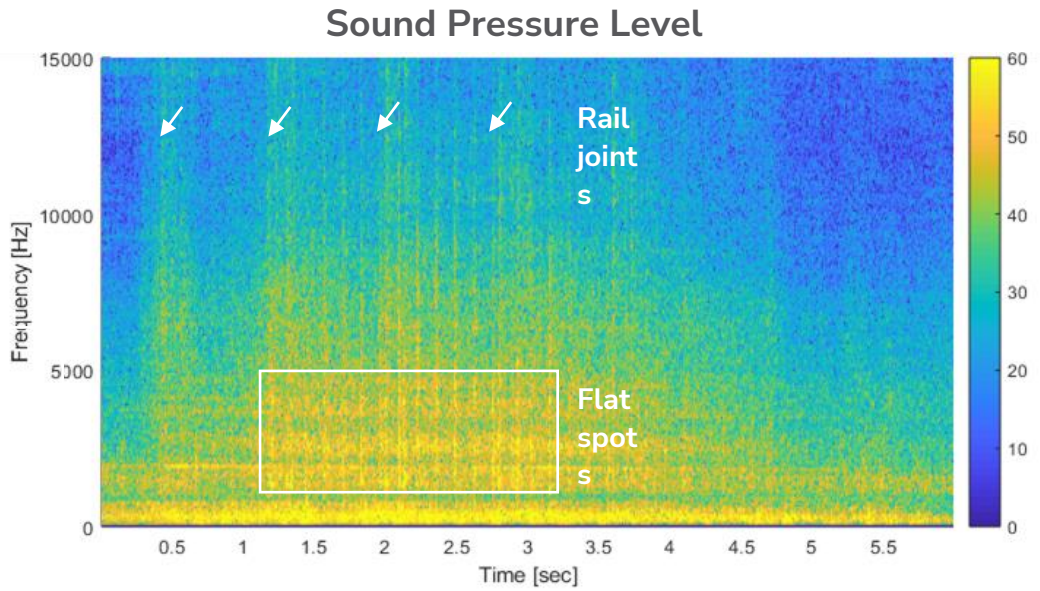
# LOCALIZATION OF FLAT-SPOTTED RAIL WHEELS

**Task**
Identification of flat-spotted rail wheels based on pass-by measurements for the entire fleet.

**Measurement**
Vehicle at a constant speed of 50kph, Sound Scanner P50 at a distance of 20m with parallel alignment to the track.

**Result**
Center undercarriage shows strong indications of flat-spotted rail wheels.



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# SOUND EMISSIONS FROM CONSTRUCTION EQUIPMENT

**Task**

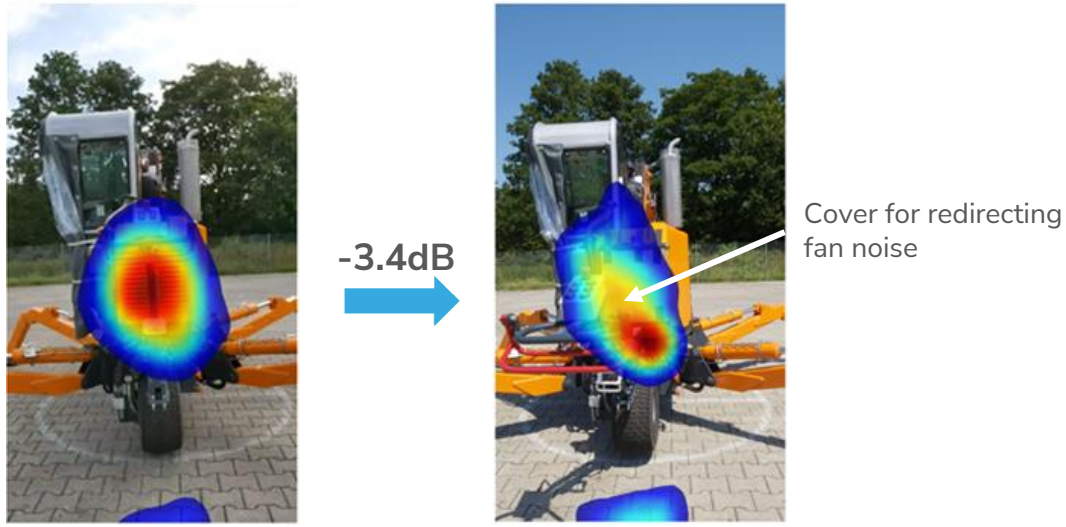
Finding a balanced circumferential sound emission of a construction vehicle in order to meet regulatory noise requirements.

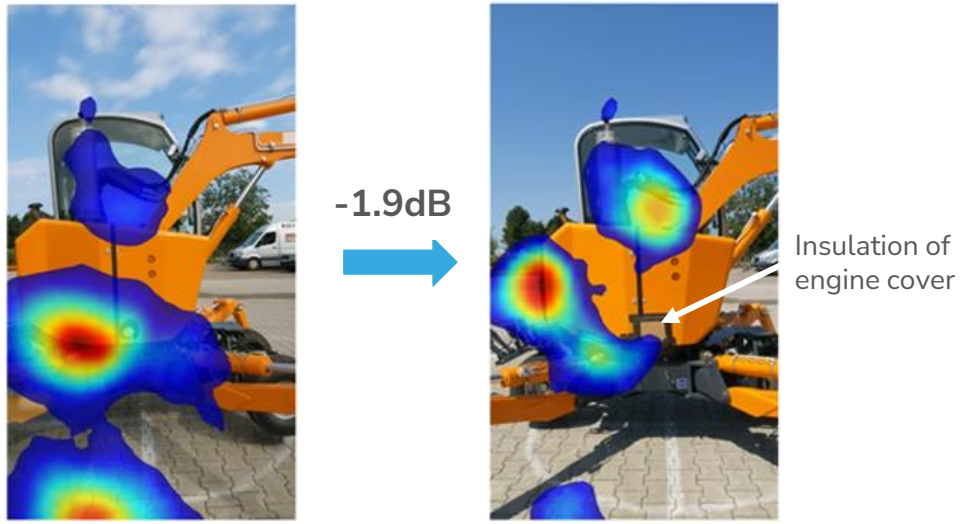
**Measurement**

Vehicle in stationary worst-case operating condition, Sound Scanner P132 at a distance of 2.5m focusing on the vehicle from various angles.

**Optimization measures**

- Redirection of fan noise to the sides of the vehicle.
- Insulation of the engine cover around the tank cap.



# ENVIRONMENTAL NOISE
# APPLICATIONS

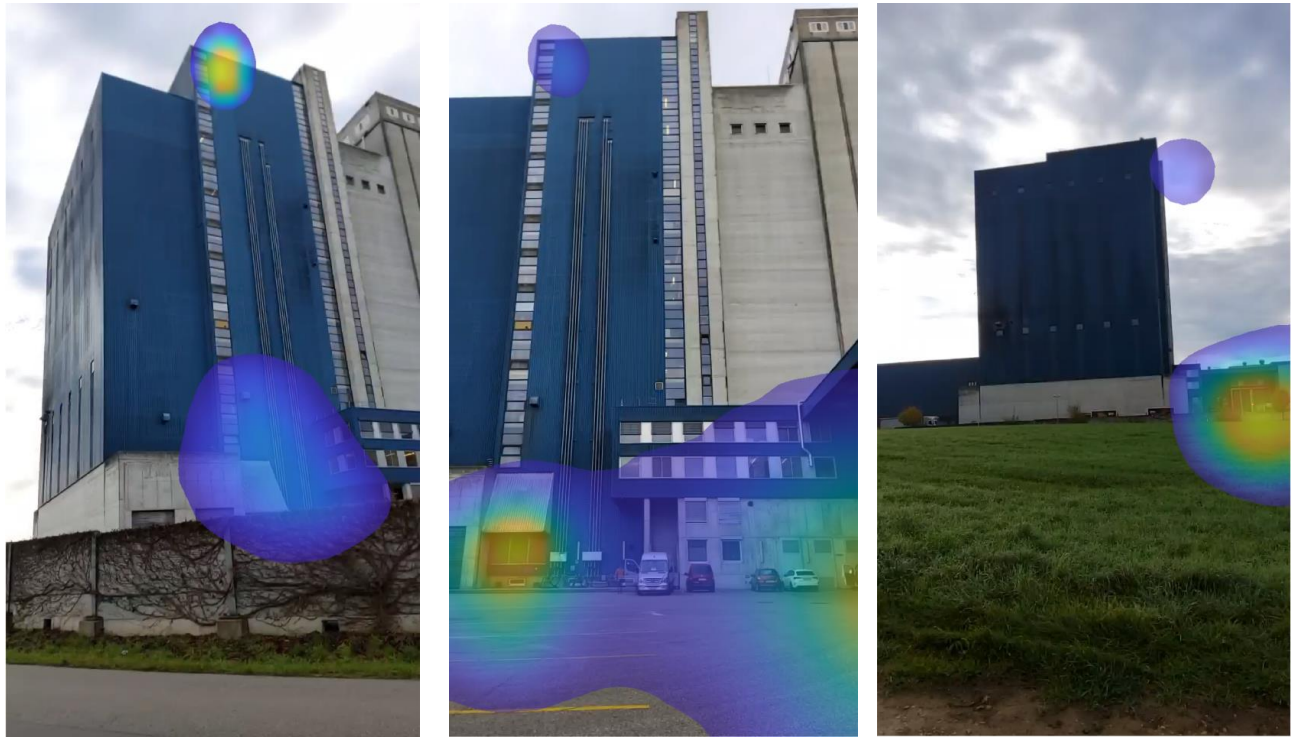
# SOUND EMISSIONS FROM A PRODUCTION PLANT

**Task**
Localize dominant sound emissions from a production plant under various viewing angles (behind a noise barrier and on premise) incl. quanitification of sources.

**Measurement Setup**
Sound Scanner P132 at a distance of 40m up to 120m. Acoustic image is averaged over a period of ~10secs.

**Root cause**
Sound transmission of machinery noise through weakly insulated wall at the top of the building.

**Solution**
Improve insulation at the top of the building.



# BUILDING ACOUSTICS
# APPLICATIONS

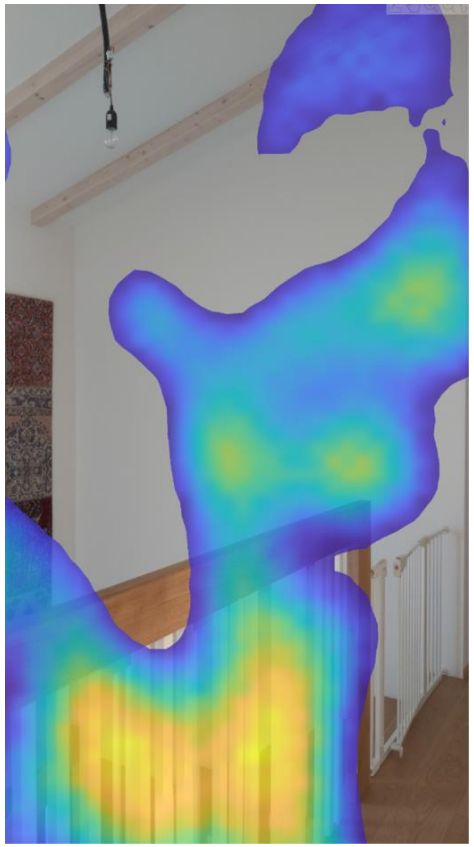
# SOUND PROPAGATION IN DETACHED HOUSE

**Problem**
Sound transmission from the dining room on the ground floor to the children’s room on the first floor.

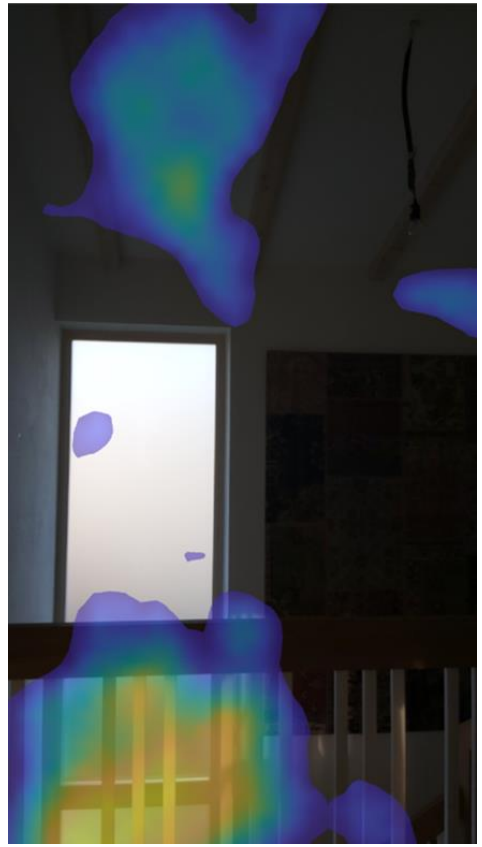
**Measurement setup**
Omnidirectional speaker in the kitchen area,
Sound Scanner in the doorway of the two children's rooms facing the stairwell.

**Root cause**
Sound reflections from window, sloping roof and walls.

**Solution**
Sound absorbers fitted in the gallery area and on the ceiling, reduction > 6dB.



ROOM 1



ROOM 2

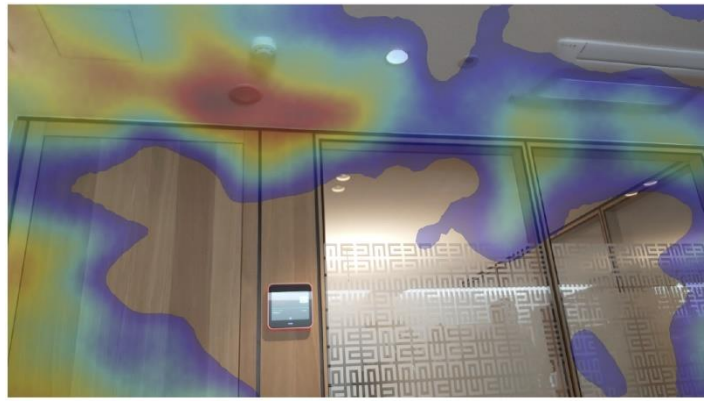
# SOUND LEAKAGE IN MEETING ROOM

**Problem**
Sound transmission between meeting room and work area not meeting standards.

**Measurement setup**
Omnidirectional loudspeaker in the meeting room, Sound Scanner in the working area facing the meeting room.

**Root cause**
Leakages at window frames, door sealings and ducts.

**Solution**
Improvements to window frames, door sealings and ducts at indicated locations.



# SOUND BRIDGE BETWEEN ROOMS

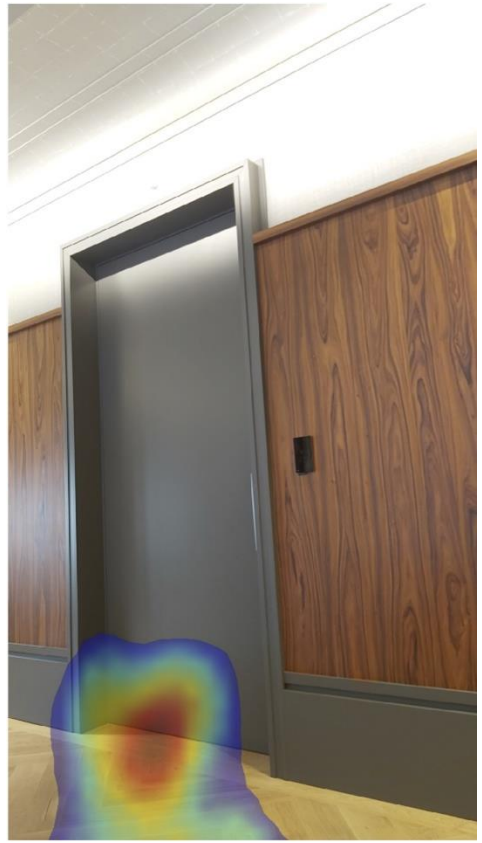
**Problem**
Sound transmission between meeting room and reception area not meeting standards.

**Measurement setup**
Tapping machine outside the meeting room,
Sound Scanner in meeting room facing door.

**Root cause**
Dominant transmission of structure-borne noise below 1kHz.

**Solution**
Rework of the parting line in the doorway.

250Hz – 1kHz



1kHz – 4kHz

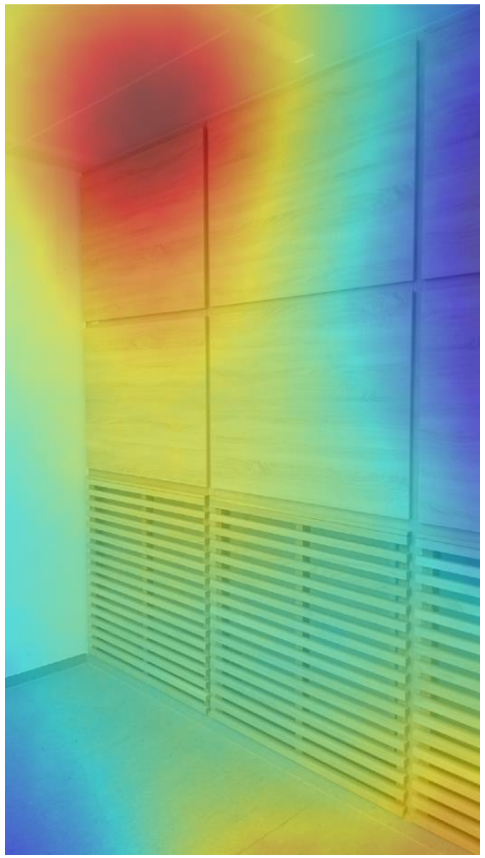
# SOUND TRANSMISSION FROM HVAC UTILITY ROOM

**Problem**
Sound transmission between HVAC utility room and seminar room (University of Vienna).

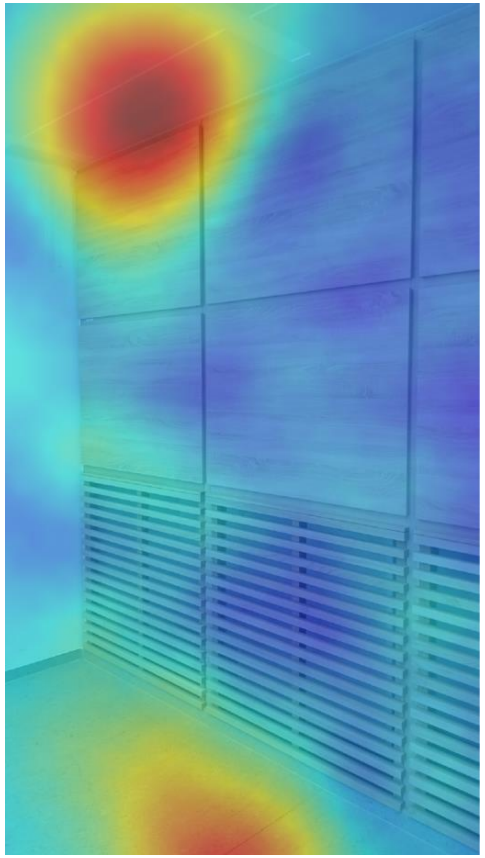
**Measurement setup**
Sound Scanner in the seminar room facing air intake.

**Root cause**
Sound emissions at the gap between the wall cladding and the ceiling.

**Solution**
Rework of the plasterboard construction behind the wall cladding including installation of insulation measures.



250Hz – 1kHz



1kHz – 4kHz

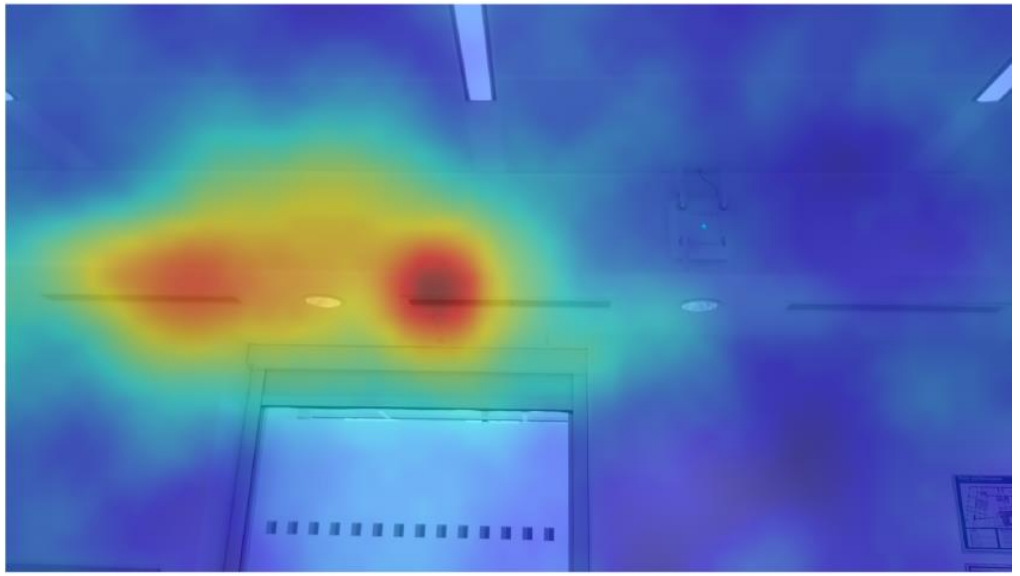
# DISTURBING NOISE AT EXHAUST AIR DUCTS

**Problem**
Disturbing noise at exhaust air ducts at max. power level of the HVAC system (~50dBA, University of Vienna).

**Measurement setup**
Sound Scanner in the seminar room facing exhaust shafts.

**Root cause**
Surge in flow-induced noise at shaft #2. Shaft #3 quieter by 4dB.

**Solution**
Simulation of the flow velocities in the exhaust air duct including redesign of the duct.



# APPLIANCES
# APPLICATIONS

# LEAKAGES IN A REFRIGERATOR DOOR

**Task**

Localisation of leakages in door seals of a refrigerator door. Samples pulled from production line for monitoring variations in assembly process.

**Measurement**

Ultrasound speaker operating at a frequency of 40kHz inside the refrigerator,
Sound Scanner P12 at a distance of 1.4m focussing on the respective sections of the refrigerator.

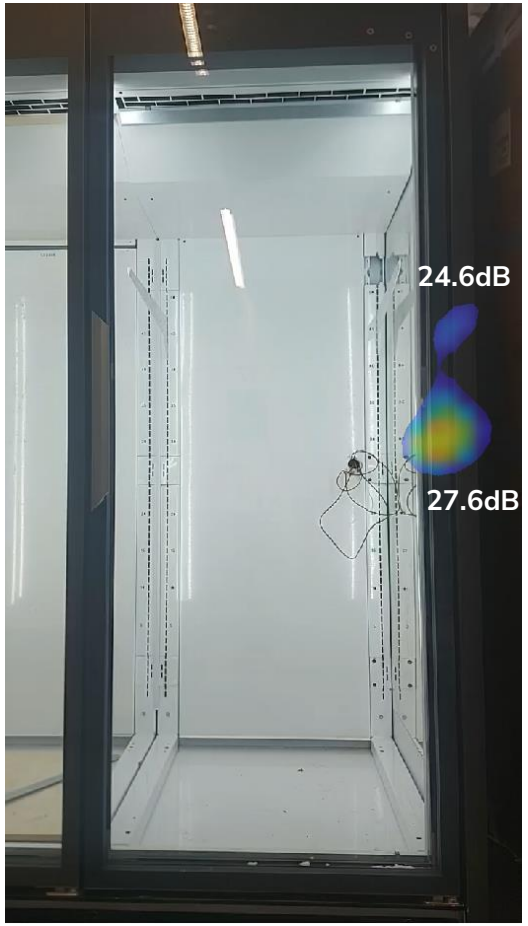
**Result**

Irregular distribution of surface pressure in the area of window and door sealings.

LEFT SECTION


DISTANCE **1.4m**
FREQUENCY BAND **35kHz – 44kHz**
SPL AT POINT OF MEASUREMENT **34.9dB**
MAX. SPL IN IMAGE **18.7dB**
DYNAMIC RANGE **3dB**

RIGHT SECTION




DISTANCE **1.4m**
FREQUENCY BAND **35kHz – 44kHz**
SPL AT POINT OF MEASUREMENT **44.3dB**
MAX. SPL IN IMAGE **27.6dB**
DYNAMIC RANGE **3dB**

Customer: Liebherr Houshold Appliances

# SOUND EMISSIONS FROM A STRAPPING TOOL

**Task**
Localization of sound emissions from strapping tool Signode BXT3-19 with closed, partially open and removed housing parts during the welding process.

**Measurement Setup**
Sound Scanner P50 at a distance of 22cm focussing on lateral surface of the tool.

**Result**
Averaged sound pressure level decreases by 3dB with removal of housing parts indicating a directed emission of the processing noise. Main source sitting in welding area.

Customer: Signode

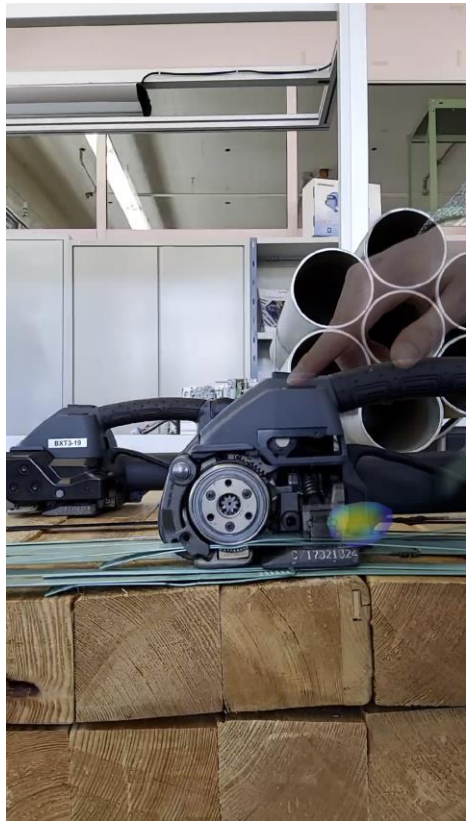
CLOSED


SPL 103DBA

PARTIALLY OPEN

SPL 102DBA

OPEN



SPL 100.6DBA

**SETTINGS FOR ALL IMAGES**
FREQUENCY RANGE 50HZ – 10.6KHZ
DYNAMIC RANGE 1DB

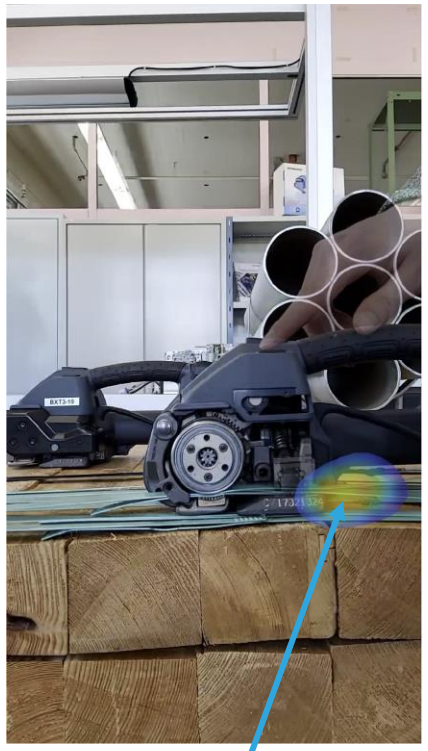
# SOUND EMISSIONS FROM A STRAPPING TOOL

### Insights

The frequency spectrum of the welding process shows a homogenous distribution of sound power ranging from low to high frequencies starting at 250Hz incl. corresponding harmonics.

Depending on the chosen frequency band, contributions from various components appear and can be addressed to reduce sound emissions, e.g. vibrations from the tape.

FREQ RANGE **3KHZ – 6KHZ**



SPL **94DBA**

TAPE VIBRATIONS

FREQ RANGE **8KHZ – 10KHZ**

SPL **96.5DBA**

GUIDE VIBRATIONS

Customer: Signode

# SOUND EMISSIONS FROM A COFFEE MAKER

### Task

Localize distribution of sound sources at the front, reverse and lateral surfaces of a De'Longhi Magnifica coffee maker. The coffee maker produces a wealth of different sounds depending on the state of operation (cleaning, grinding, rinsing, pumping water, descaling, etc.). The scope of this report addresses the grinding process.

### Measurement Setup

The coffee maker is placed at the edge of a table. The Sound Scanner P50 is positioned at a distance of 50cm with the measurement plane aligned in parallel with the front, reverse and lateral surfaces of the coffee maker.

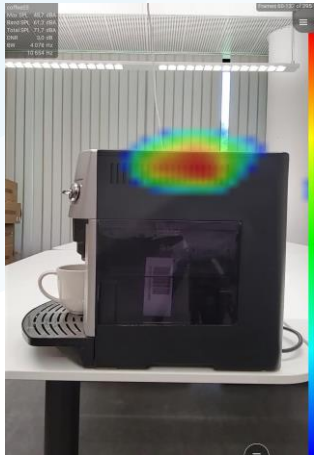
### Result

The following acoustic images show the distribution of sound sources for the front, reverse and lateral surfaces in the lower and higher frequency bands. The corresponding band-limited sound pressure levels are given for each of the surfaces.


Customer: Flex

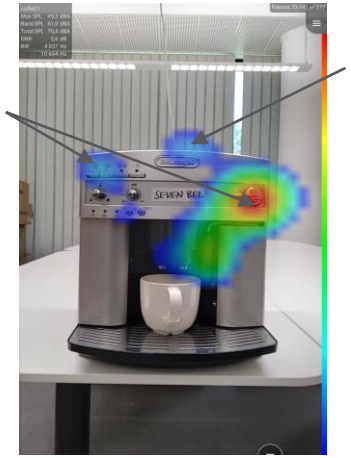
# SOUND EMISSIONS FROM A COFFEE MAKER

## BEAN GRINDING PROCESS - HIGH FREQUENCY BAND (4000HZ – 10600HZ)



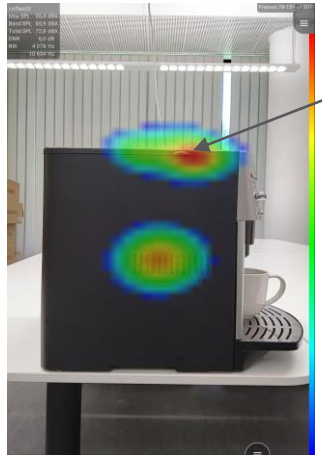
61.3DBA

FRONT PANEL LEAK OR EXCITATION



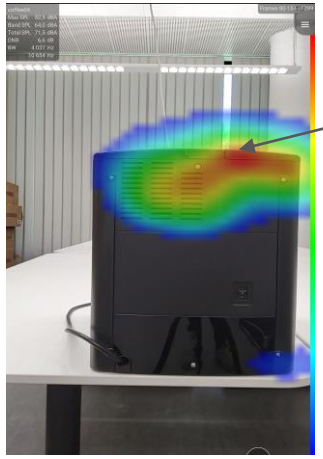
61.0DBA

CENTER LID



65.9DBA

GRINDING NOISE ESCAPING THROUGH LID



64.0DBA

GRINDING NOISE ESCAPING THROUGH LID

Customer: Flex

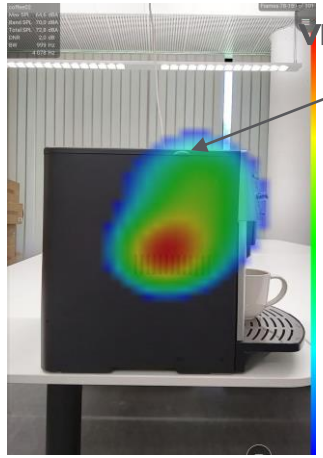
# SOUND EMISSIONS FROM A COFFEE MAKER

## BEAN GRINDING PROCESS - LOW FREQUENCY BAND (1000HZ – 4000HZ)

69.3DBA

FRONT PANEL EXCITATION

67.7DBA



VENT AND PANEL EXCITATION

70.0DBA

VENT

68.8DBA

Customer: Flex

# SOUND EMISSIONS FROM A COFFEE MAKER

## SUMMARY

- The sound emissions of the grinding process contain considerable power in the low and high frequency bands.
- The right lateral surface is the loudest surface at 72.8dBA when the coffee maker is grinding beans.
- Grinding noise escapes from the vents, lid of the bean container and buttons of the front panel at higher frequencies.
- The front panel and right lateral surface is excited and vibrates at lower frequencies.

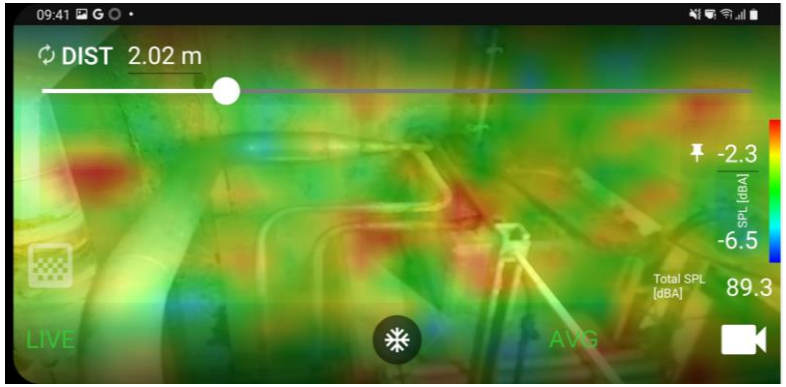
# MAINTENANCE
# APPLICATIONS

# LOCALIZATION OF GAS/COMPRESSED AIR LEAKS

- Compressed air leaks generate sound events in the audible and ultrasonic frequency band.
- To make a reliable assessment in a noisy production environment, the localization of leaks occurs in the ultrasonic range, typically between 25kHz and 44kHz.
- A leaks manifests as a point source in the acoustic image with a significant sound pressure level.
- In contrast, uncritical sound events in a noisy environment appear as a "blurred" acoustic image with numerous acoustic reflections and very low sound pressure levels (< 10dB).

**SIGNIFICANT LEAK IN AN INSTRUMENT AIR LINE**
**SOUND PRESSURE LEVEL (SPL) 51.6DBA**
**FREQ BAND 25KHZ – 44KHZ**


**NO LEAK**
**SOUND PRESSURE LEVEL (SPL) -2.3DBA**
**FREQ BAND 25KHZ – 44KHZ**

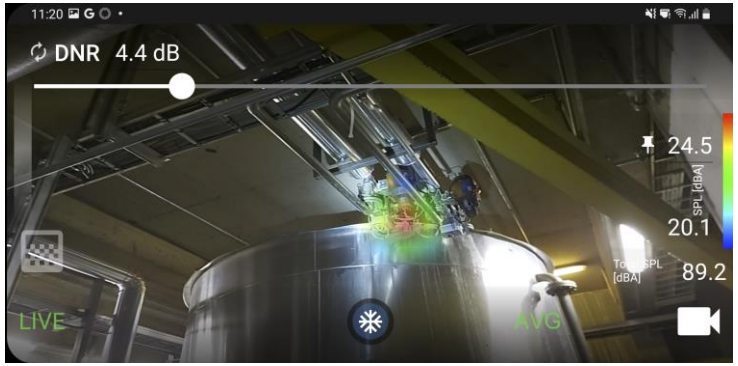


# LOCALISATION OF LEAKS IN POSITIONER VALVES

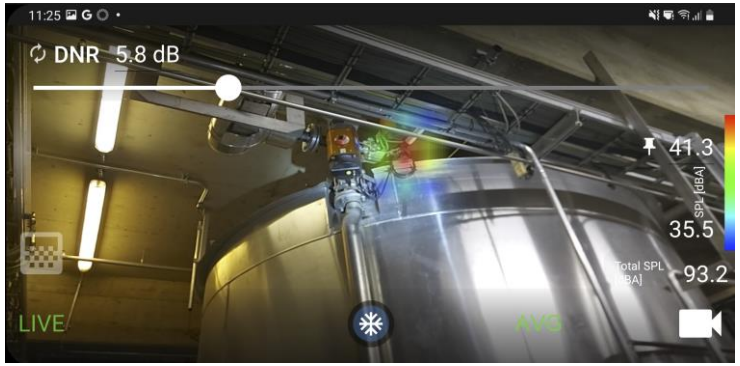

SPL AT 1M **41.4DB**
DISTANCE **2.3M**
SPL AT MEASUREMENT DISTANCE **34.2DB**


SPL AT 1M **32.8DB**
DISTANCE **0.8M**
SPL AT MEASUREMENT DISTANCE **34.8DB**

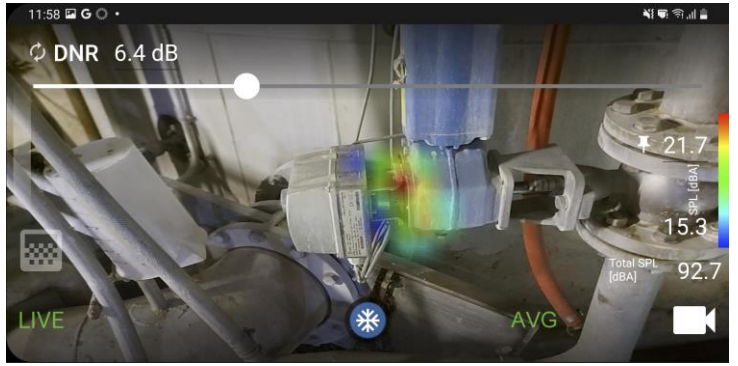

SPL AT 1M **32.5DB**
DISTANCE **0.8M**
SPL AT MEASUREMENT DISTANCE **34.5DB**




SPL AT 1M **36.5DB**
DISTANCE **4M**
SPL AT MEASUREMENT DISTANCE **24.5DB**




SPL AT 1M **50.8DB**
DISTANCE **3M**
SPL AT MEASUREMENT DISTANCE **41.3DB**




SPL AT 1M **21.7DB**
DISTANCE **1M**
SPL AT MEASUREMENT DISTANCE **21.7DB**

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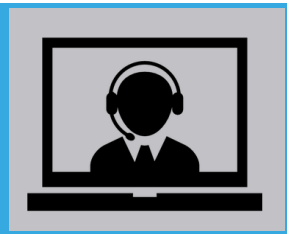
# SOUND SCANNER
# EXPERIENCE

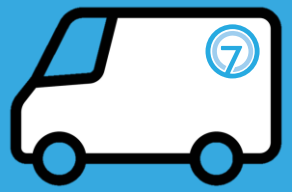
# BECOME FAMILIAR WITH THE SEVEN BEL SOUND SCANNER

## ONLINE DEMO



DISCUSS YOUR APPLICATION WITH OUR EXPERTS AND GET A LIVE DEMO OF THE FEATURES AND OPERATION OF THE SOUND SCANNER.

## ON-SITE DEMO



OUR EXPERTS WILL ANALYSE YOUR APPLICATION TOGETHER WITH YOU. SERVICE STARTS FROM €1.950 EXCL. TRAVEL EXPENSES. BRIEFING AND MEASUREMENT REPORT INCLUDED.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# QUESTIONS?

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# SEVEN BEL – THE COMPANY

**FOUNDED:**
2018

**HEADQUARTERS:**
LINZ, AUSTRIA

**R&D / ASSEMBLY:**
AUSTRIA


**MISSION STATEMENT**

Make sound imaging a standard measurement in engineering, production and maintenance through easy-to-use and affordable products.