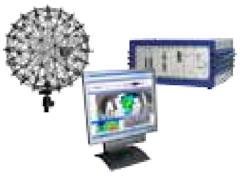
# Application Note.
# Room and Building Acoustics.

acoustic camera

## System Characteristics



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| **Array Sphere120** |
| 120 microphones |
| 60 cm diameter |
| Carbon fiber structure |
| Dynamic of the microphones: 35 dB -130 dB |
| Recommended mapping frequencies: 400 Hz - 20 kHz |
| Typical measurement distance: starting at 0.8 m |

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| **Data Recorder** |
| 192 kHz Sampling frequency |
| 48 to 144 channels per 10 inch rack (24 channels per card) |
| Ethernet Interface > high transfer rate > 20 MByte/s, network-compatible |
| Digital card with 12 extra channels for recordings of RPM, rotation angle, reversal point, etc. |
| Integrated PC with Windows XP (embedded) |

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| **Software** |
| NoiseImage3 Acoustic Photo 3D |
| **Power Supply** |
| Mobile power supply / battery pack |

## 3D Measurements – Interior source mappings
## Office room measurements

This application note explains how the Acoustic Camera is used for room and building acoustics. Here, the propagation of sound inside of closed rooms like office and administration rooms, cinemas, concert halls, etc. is examined. The aim is to tackle sound transmission in the form of airborne and structure borne noise, respectively. The Acoustic Camera is applied in order to find acoustically problematic zones within rooms and buildings in a single measurement. The application note shows how manually generated noise as well as operation noise is located within an office room.

## Application area

Analysis of acoustic conditions inside of rooms

## Measurement task

Localization and mapping of different signals inside an office room

## Measurement object

Office room

## Measurement set up

In all following measurements the acoustically transparent spherical 120 channel microphone array has been used. Furthermore, 3D CAD models were generated using the software FinalSurface of the GFaI. The array was positioned in the centre of the room. The recording sampling rate was 192 kHz. Several measurements with various sources have been conducted inside the office room.

## Results

The first analysis was conducted in order to validate the results of the Acoustic Camera. Therefore, a shredder was introduced into the CAD model of the office room using the software FinalSurface (GFaI). Figure 1 and 2 show the Acoustic Photos in 3D with the shredder in operation. Figure 1 shows that the main source is sitting on the top right corner of shredder while even visualizing some minor reflection off the ceiling. Figure 2 shows a close-up visualizing the exact position of the motor. This measurement proves that the Acoustic Camera has located a known sound source in 3D as expected.

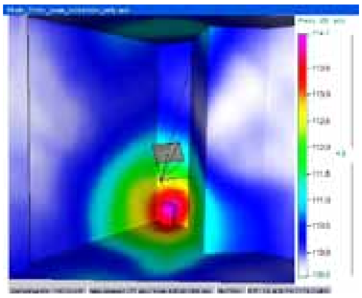

Fig. 1 Shredder in operation

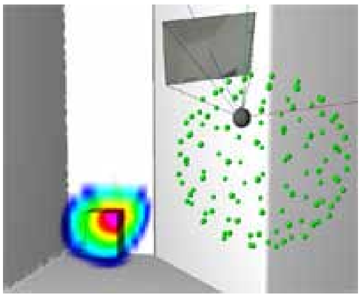

Fig. 2 Close up view shredder motor

The next session was conducted while knocking on the outside wall of the office room. The person on the left is using his bare palm while the one on the right is holding a plastic device in his hands (see figure 3). Only one measurement was conducted while both people were knocking at the same time. The recorded data was used to find the acoustic hotspots within room. The results are presented in figure 4 and 5.

For the first impact with the bare palm of the hand an excitation of the ventilation shaft on the bottom right is clearly visible in figure 4. This acoustic hotspot was calculated over all frequencies while a frequency selective analysis could follow. Secondly, the plastic device has been investigated. The hollow region below the area of impact also gets excited as seen as a second source of airborne sound (see figure 5).

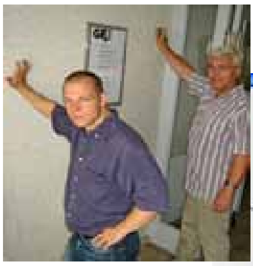

Fig. 3 Knocking on the outside wall of the office room with hand / plastic device

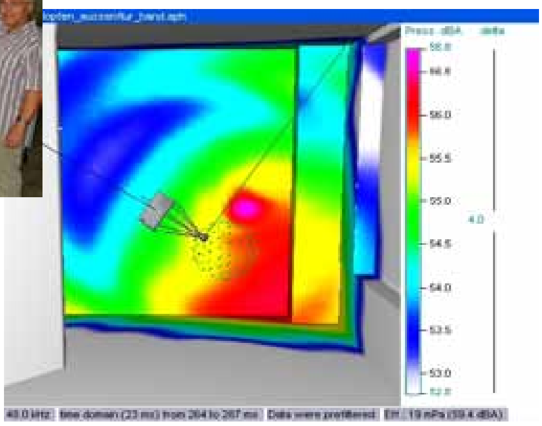

Fig. 4 Acoustic Photo of hand knocking showing excitation of ventilation shaft

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Fig. 6 Knocking with two different hammers from the office room above

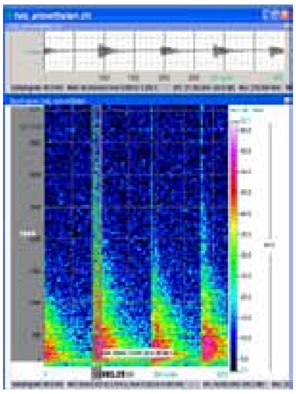

Fig. 7 Channeldata and spectrogram of hammer knocking

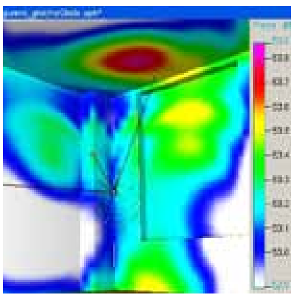

Fig. 8 Acoustic Photo, Hammer impact and reflection

For the second measurement one person was knocking on the floor of the office room above with two hammers as shown in figure 6. The spectrogram (figure 7) shows the knocking impacts as time, frequency and level information. The impact of the hammer in the room above can be seen in figure 8. Also the reflection becomes visible, especially on the ground. By this type of measurement acoustical bridges can be found easily and the necessary means can be implemented after the localization.

For the fourth test a white noise source has been placed outside in the center of the window while this was closed (see figure 9). Figure 10 shows the acoustic photo with a 1-10 kHz filter. Clearly the isolation of the window is poor in the area of the acoustic hotspot on the top.

In the last test the window was tilted while the source remained. The Acoustic Photo 3D now displays the window frame additionally (figure 11 and 12). It is important to note the level differences in both measurements: When the window was closed the overall sound pressure level was at 36.1 dB(A) as opposed to 61.7 dB(A) with an open window.

## Conclusion

With the Acoustic Camera it can be analyzed how noise is propagating within buildings and rooms in order to find efficient means for isolation. The big advantage the Acoustic Camera offers is that it is keeping the recorded data in the time domain. By this means the time information remains and especially echo and reflections can be differentiated easily form the actual emission. Last not least the effectiveness of sound supply, like music or speech, to the people within the room can be inspected, which is explained in the application note building acoustics.

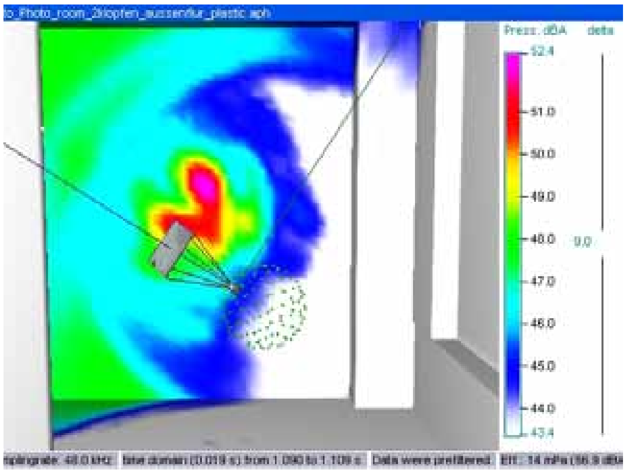

Fig. 5 Acoustic Photo of plastic device knocking showing hollow area

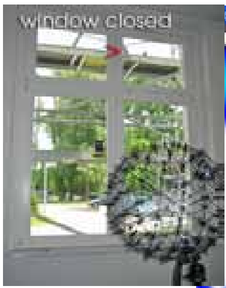


Fig. 9 White noise source outside office room, window is closed

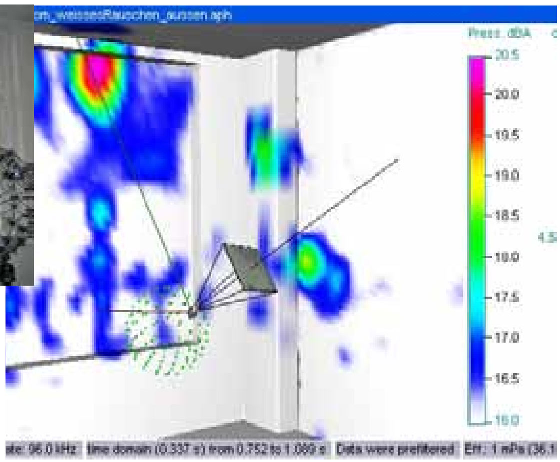

Fig 10 Acoustic Photo 3D of poor isolation, sound pressure level of loudest source: 20.5 dB(A)

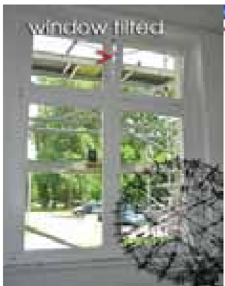


Fig. 11 White noise outside the window, window is tilted

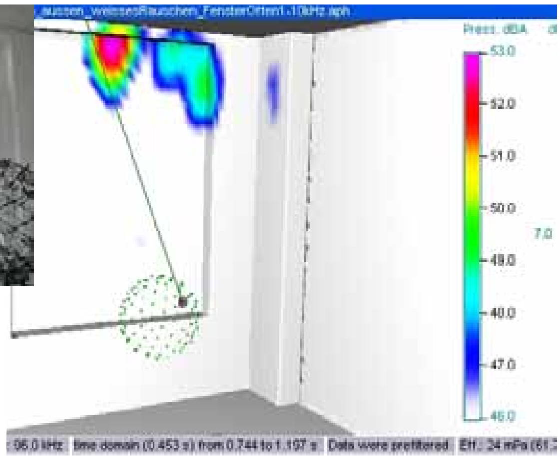

Fig 12 Acoustic Photo 3D displaying white noise source from 1 to 10 kHz, sound pressure level of loudest source: 53 dB(A)

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