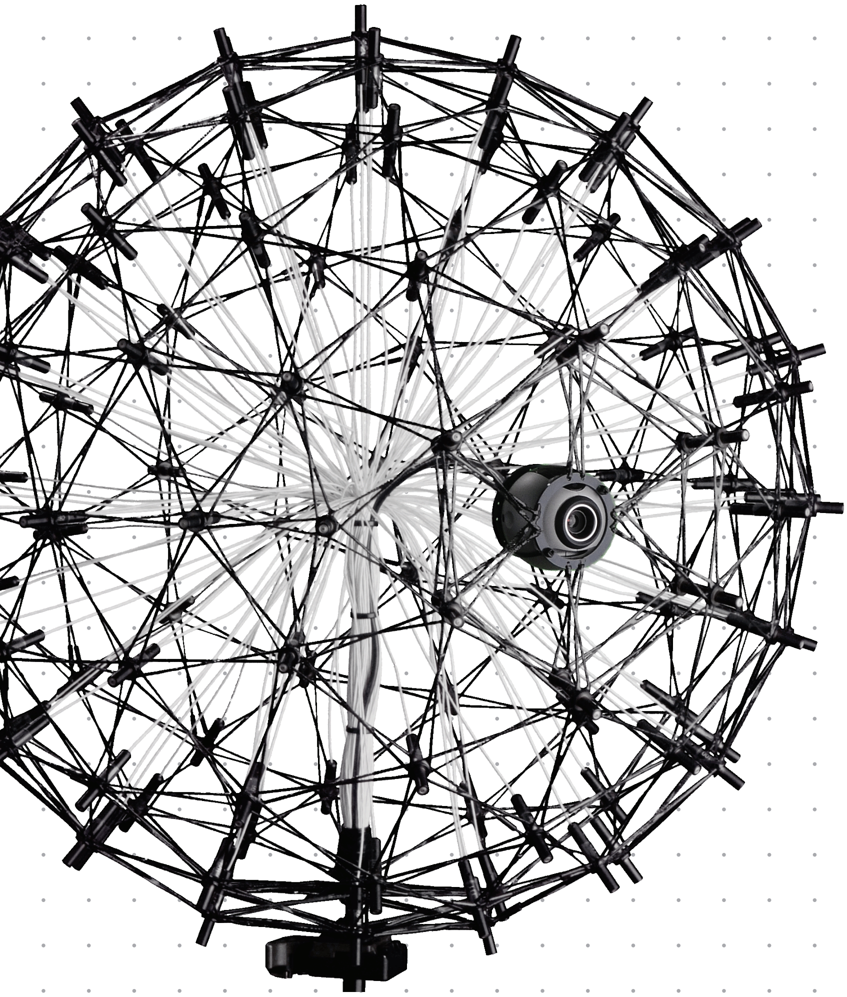
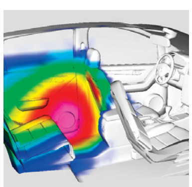
acoustic camera

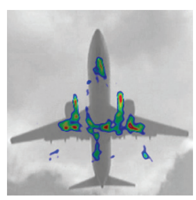
The Original.



Acoustic Camera.
Listening with your eyes.







We are the pioneers in acoustic imaging systems – and world market leader!

Acoustic Camera – The original.

gfai tech's **Acoustic Camera** was the first commercially viable system to localize acoustic emissions. Brought to market in 2001 as a pioneer technique, the **Acoustic Camera** has become a metaphor for beamforming systems over the years.

gfai tech's **Acoustic Camera** remains "The Original" and continues to surpass any competitor products both technically and when applied 'in the field' – proven by the trust and steadily growing number of customers from various industries, ranging from automotive and aerospace to engineering and consulting.

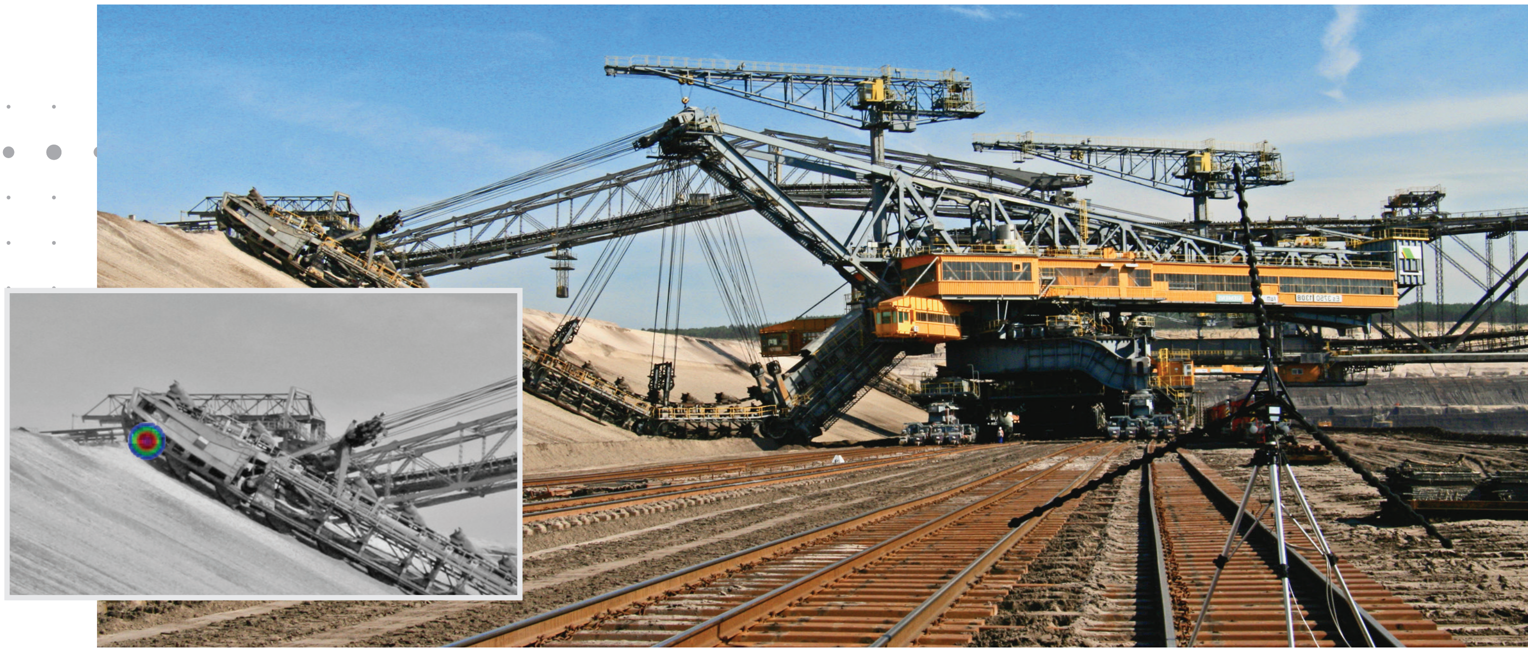
Our success is built upon three pillars: innovative power, strict quality standards and the solid engineering capabilities of our team. We are in constant contact with our customers from all over the world and use their feedback to develop the **Acoustic Camera** further and adapt the system to our clients' needs.

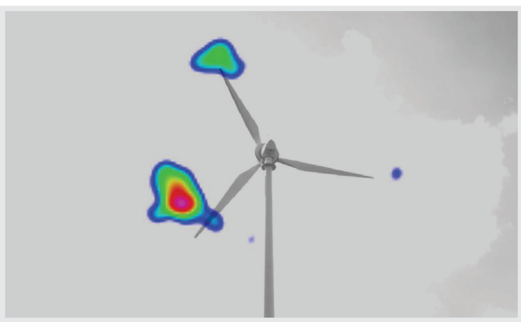
Contents.

Company profile.

The Society for the Advancement of Applied Computer Science **(GFaI e.V.)**, where the **Acoustic Camera** was designed, was founded in 1990 with its headquarter in Berlin. The institution offers custom R&D services. The list of references of successful projects ranges from small and medium sized enterprises to research institutes and major corporations.

gfai tech GmbH is a wholly owned subsidiary of GFaI e.V. and is responsible for the production and marketing of the GFaI e.V. product line.





Above: Measuring a mining bridge with the Star Array.

Left: Measurement of a wind turbine

Noise – Environmental sound pollution.

Sound and noise are omnipresent in our everyday life. Unlike your eyes you can never close your ears. Increasing traffic on the ground and in the air, more powerful machinery and tools are only a few examples contributing to an increasing noise level which affects people's everyday life and pollutes the environment.

The first step in making the environment quieter and more comfortable is to perform a detailed analysis of the undesired noise sources in a fast and efficient way.

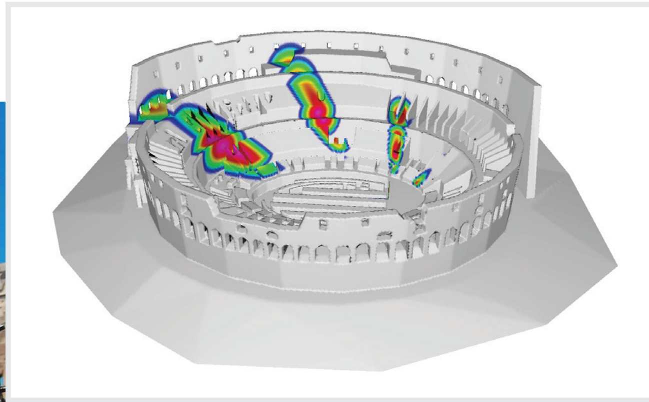
Designers and engineers can take effective measures to reduce noise only if the sources of noise emission are exactly known. But this is where the problems usually start: Which components, assemblies or installations are really responsible for noise emissions? How is it possible to measure and document the successfully identified noise?

Acoustic Camera – Listening with the eyes.

Using their eyes, human beings can gather information more quickly and with more flexibility than with any other sense organ. This is why complex processes are "visualized" and great technical effort is made to extend vision to fields that the eye usually cannot see. X-ray machines, magnetic resonance imaging devices and infrared cameras are only a couple of examples for technical instruments visualizing the invisible.

As far as sound is concerned, the developments are less advanced. What would be the advantages if sound was visible?

The Acoustic Camera. Intelligent problem solver – universally applicable.



Noise measurement at the Colosseum in Rome.

Product sound – Product quality.

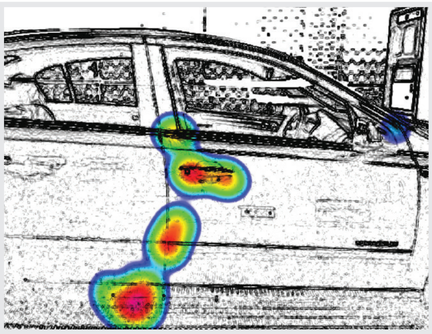
Sound is an important quality aspect. Year after year, the automotive industry invests tremendous amounts of money to locate and analyze noise sources and to reduce their intensity if not their occurrence. The characteristic sound of a car has always been a very important marketing argument. A sports car must be distinguishable by its characteristic sound when it passes by. Any type of side tone is undesired and must be eliminated. How is it possible to achieve these aims faster and more effectively than ever before?

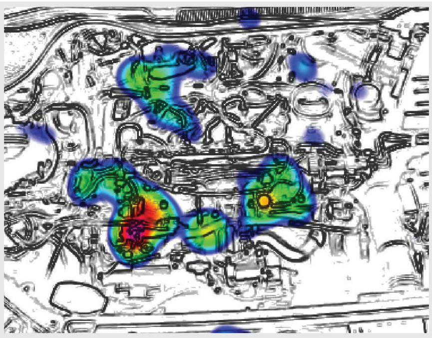
Acoustic quality assurance.

Faults in machinery and plant installations can often be detected by a change in their noise emissions. An experienced mechanic can actually hear a fault. Some manufacturers rely on the excellent hearing skills of a few staff members to identify faulty products in the final quality control. How can tests like these be automated and made more objective?

The solution: making sound visible – Fast and easy

The **Acoustic Camera** delivers a groundbreaking tool to solve these types of problems. For the first time, a portable system can be used to visualize sounds and their sources. Maps of sound sources that look similar to thermographic images are created within seconds. Noise sources can be localized rapidly and analyzed according to various criteria.





Ring Array for exterior measurements visualizing acoustic sources in 2D.

Photographing and filming sound.

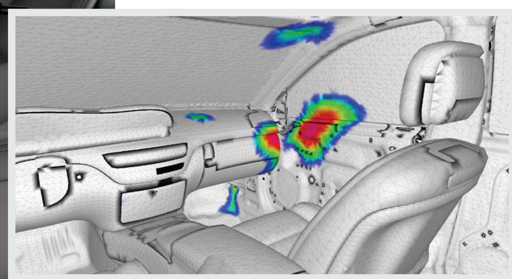
There is a simple, yet ingenious idea behind this revolutionary solution. A digital camera is used to acquire an image of the noise-emitting object. At the same time an exact defined array of microphones records the sound waves emitted by the object. Dedicated software then calculates a sound map and combines the acoustical and the optical images of the noise source.

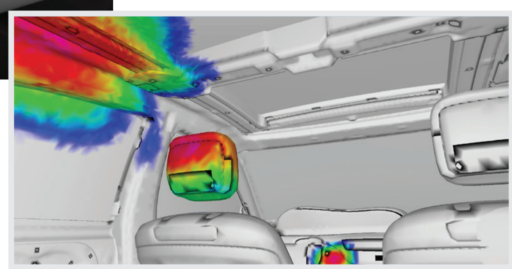
The handling and operation of the **Acoustic Camera** is almost as easy as with a common camera. You can monitor the target object in real time on-screen in a preview window. When you are done with the setup you just press the "shutter release button" – and that's it! The acoustic "fingerprint" of the target object has been acquired.

The computer can calculate various sound maps, i. e. acoustic still images or videos. The complete soundscape which usually consists of a combination of many sound sources can be broken down into individual sources which are displayed through different coloring. The map visualizes the distribution of the sound pressure. It is now possible to identify the relevant sources of high sound levels.

Up to now, this has never been done within a short time frame. The **Acoustic Camera** has established itself as an indispensable tool whenever fast and reliable answers are needed.

Fast results. Visualization in real-time or as acoustic fingerprint.





Above: Sphere Array for interior measurements.

Right: Visualization in 3D, mapping acoustic information on a 3D model.

Intelligent system concept.

Engineers in the industries work under immense pressure with respect to time and money. They need tools helping them to identify and to solve problems without creating new difficulties. Thus, the design of the **Acoustic Camera** is built upon modularity, ease of use and intuitive operation of the software.

The system comprises the microphone array with the implemented camera, a data recording device and a notebook. The customized arrays are designed for different fields of application. The array setup is done within minutes. The system is immediately ready to use.

In addition to the sound recording it is possible to acquire parameters like revolutions per minute, angle of rotation, voltages and currents. This facilitates a temporal and spatial allocation of sound sources to the operating state of the measured object.

Set-up for acoustic measurement of industrial plant and Acoustic Photos 2D.

Noise reduction – A compelling task for industrial companies.

Noise – an often underestimated pollutant. The human heart rate increases when exposed to sound levels above 65 decibels. At night, when cars and other vehicles only penetrate the subconsciousness, traffic noise can disturb human's health by affecting the quality of sleep.

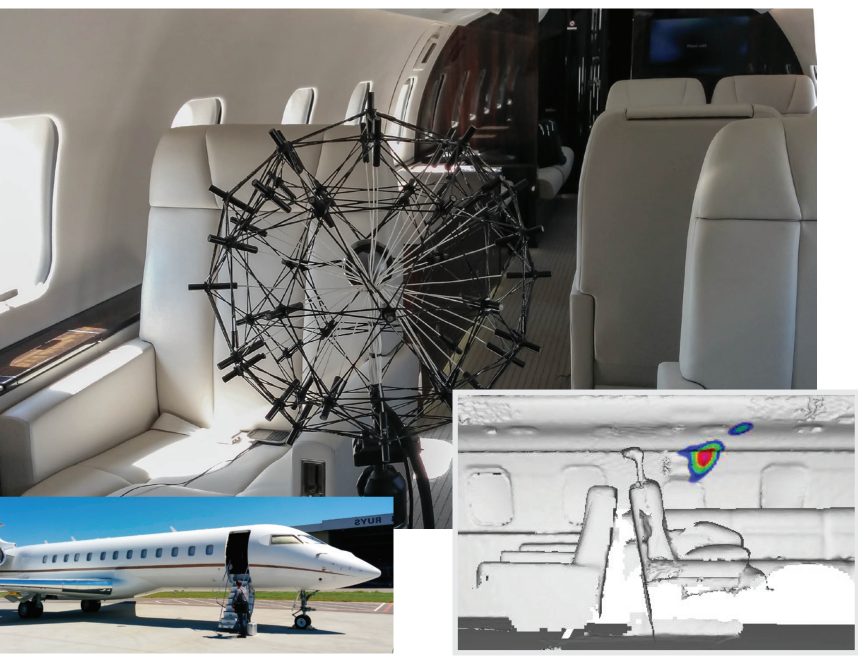
Legal requirements for the operation of technical devices are becoming more and more stringent. This is the case not only for planes and industrial installations but also for a lot of electrical equipment. In addition, lower noise level is a good sales argument. However, machines and equipment must become more and more powerful, faster and lighter which leads in many cases to increased noise emissions. Also eco-friendly wind turbines can become a factor of annoyance. To meet these conflicting demands enormous investments have been mandatory in the planning and development stages.

When traditional technology is used to measure a wind turbine, for example, data from numerous measurement points must be acquired using microphones or vibration transducers. This is certainly not an easy task taking into account the size of the object and the rotation of the blades. Afterwards it remains questionable whether the sources that are found to be especially loud are responsible for the elevated noise emissions.

There is always the risk of taking the wrong measures to reduce the noise emissions since these measures would be based on insufficient (and sometimes inadequate) data. When the true origins of noise exposure are not exactly known, it becomes harder or even impossible to correctly assign the responsibilities. Vast amounts of money could easily be spent without the desired effects.

High precision noise investigation. Exact localization and identification of noise sources.

Noise radiation from aircraft engines, gear and flaps and Acoustic Photo 2D.



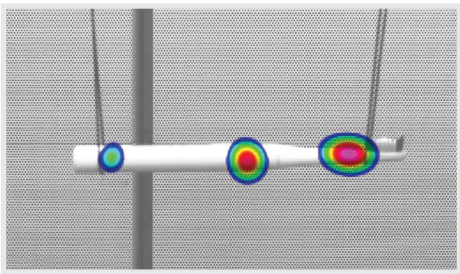
Position of Sphere Array in aircraft cabin and Acoustic Photo 3D.

Accurately identifying and documenting noise sources – In real time.

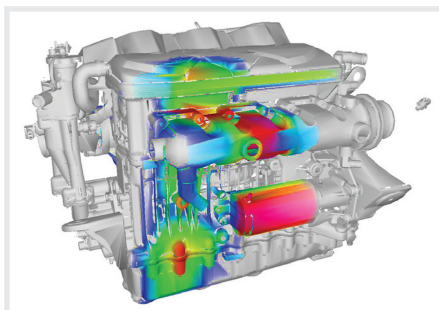
The **Acoustic Camera** can save an immense amount of time and corresponding money. Noise sources can be localized rapidly and very precisely from the position of the listener – even at distances of several hundred meters.

The method has numerous advantages. Instead of placing microphones in a machine or plant and strenuously looking for noise sources, the object as a whole can be surveyed in only a few measurements from the relevant perspectives. Moreover, documenting the success of the noise reduction is much easier with the **Acoustic Camera** system. Gathering two acoustic images – one “before” and one “after” – can clearly show the effectiveness of a modification.

acoustic
camera



Measuring acoustic emissions from a toothbrush – set-up and result.



Above: Underhood measurement using a Ring Array.

Left: Acoustic Photo 3D of an engine.

High-quality sound brings high-quality product.

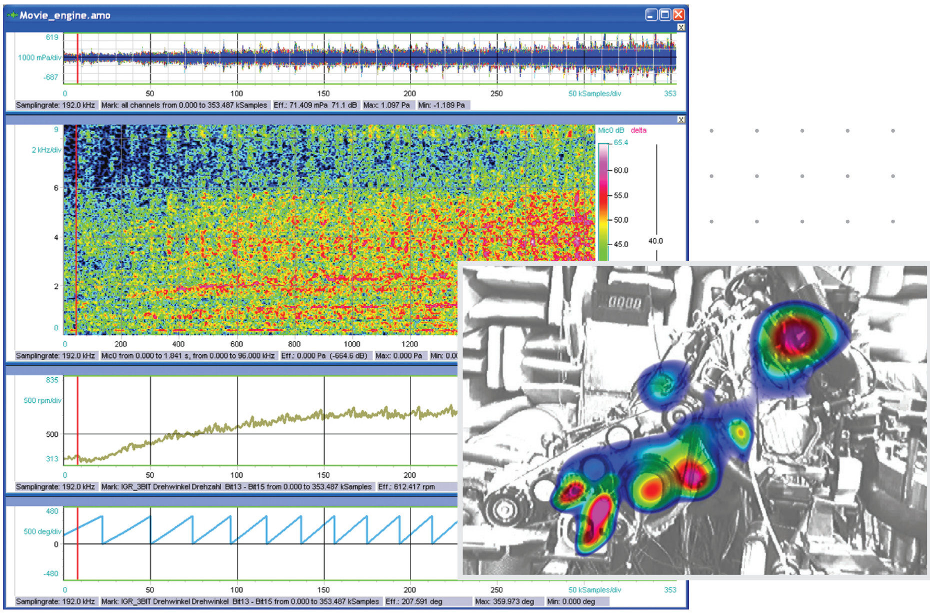
Sounds do not necessarily have to be loud to cause discomfort. In many cases there are sources far quieter than the dominant sound that seem to be psychoacoustically dominating. Some of the most significant examples for this phenomenon exist in the automotive industry where the **Acoustic Camera** has already been applied with great success.

Rattling, hissing or clicking noises are undesired in any vehicle. Even at high speed the pianissimo parts of classic music should not be drowned by driving noise. Shutting the door, however, must produce a solid sound despite the lightweight construction. There are similar requirements for the sound of car engines. The roar of a sports car or the smooth and refined sound of a sedan are typical distinctive characteristics of car brands.

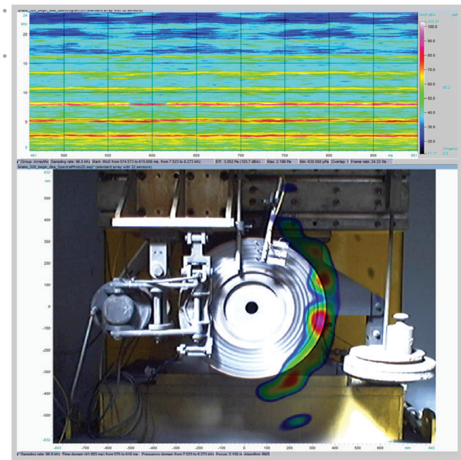
This is why a lot of effort is put into modeling the desired sound and eliminating disturbances. Sound issues are also playing an increasingly important role when it comes to household appliances. Some high-value products can already be identified by their “high-value sound”. Noises that are usually associated with faults, like clicking, crackling or whistling sounds, can irritate customers and frequently lead to unnecessary complaints.

Time, frequency and modal analyses have been the means of choice so far to trace undesired noises. But these methods have a decisive dis-advantage: The spatial resolution is limited if not missing.

Optimized spectrum of analysis. Enhanced and extended analysis methods in product design.



Engine sound relating to crankshafts angle and rpm.



Virtual scanning of a brake showing the location-selective spectrogram of mouse cursor.

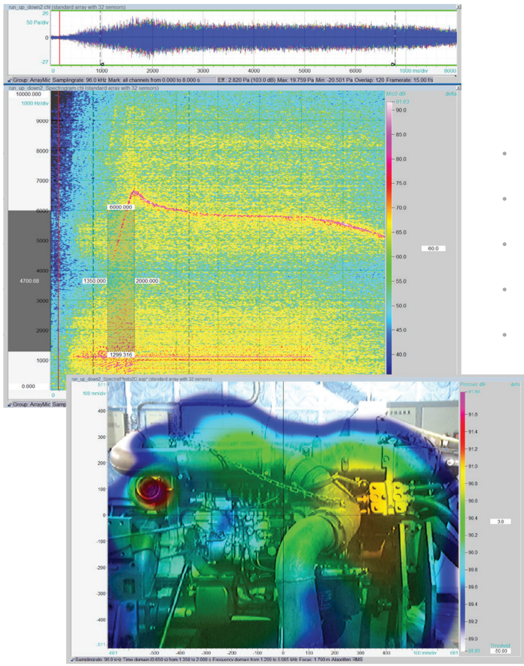
Space-, time- and frequency-selective measurements.

The **Acoustic Camera** can extend the known standard time- and frequency-selective analysis and add a location-selective component. With this method not only the progression of the sound signal is shown but a sequence of acoustic images can be acquired: Acoustic films are generated. The analysis clearly shows which sound sources are active in time and location. Extreme slow motion is possible – up to a resolution of 192,000 images per second if required. Noise paths become visible, active sound sources and passive reflections are isolated. Entirely new insights and perceptions about the development of sound and noise are offered. It is also possible to analyze sounds from moving objects.

The **Acoustic Camera** extends and enhances existing analysis methods.

The **Acoustic Camera** comprises traditional analysis methods like A-weighting, one-third octave band analysis, narrow band analysis, filters, and many more. Based on these methods far more detailed research becomes possible.

In a spectrogram, for example, sounds can be highlighted in the time and frequency domain. The **Acoustic Camera** then shows the exact origin of this sound. The approach can also be made from the other end: After selecting a spot on the measured object, the sound originating from that spot can be reconstructed, visualized and broken down into its spectral components. It is also possible to replay the sound via speakers – any time after the measurement has been completed.



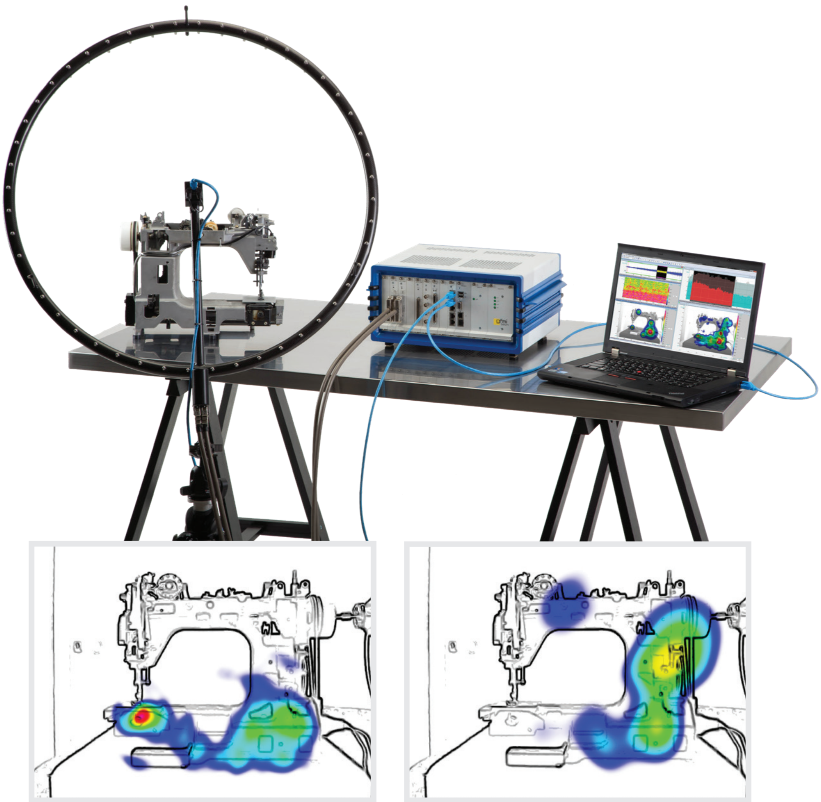
Time- and frequency-selective images (as highlighted in spectrogram)

Multi sensor technology – Virtual sound studio.

The more senses are used to gather information, the better human beings can recognize complex situations and act accordingly.

The **Acoustic Camera** acts according to the same principle. When the measurement is finished, the acoustic image/movie can be replayed virtually – as if the running machine was scanned in real-time using a directional microphone. Sound sources that are usually drowned by louder sources become audible. The image can be animated by the software resulting in an acoustic movie. The spectrum of the spot can be displayed if required.

One advantage of this method is that all calculations can be done anytime after the measurement is completed. All data required for these functionalities is recorded and saved during the measurement session. The acquired data analysis can be performed any time using a standard computer.



Clockwise from top: Ring Array measuring a sewing machine ; normal soundscape of a sewing machine; fault in bobbin mechanics

The **Acoustic Camera** facilitates identification of faults and defects.

The same is true for many industrial applications: Numerous faults can be detected just from variations in sound emission. In quality control, experienced staff can often identify faulty products just from their abnormal sound.

The **Acoustic Camera** can find faults resulting in variations in the sound field as an objective instrument without depending on the disposition of quality assurance staff. Acoustic images can be compared side by side in NoiseImage. The same value range is applied to both images with a click of a mouse button. Variations become obvious and the visual presentation also reveals where exactly the fault is located.

Individually configurable system.

Microphone Arrays.

Ring Array
for the acoustic lab.

Type	Ring32	Ring48	Ring72
Microphone surface	Ø 0.35 m	Ø 0.75 m	Ø 1 / 1.2 m
Min. measurement distance	0.3 m	0.5 m	0.75 / 1 m
1/4" electret pressure microphones quantity	32	48	72
Maximum sound level	130 dB(A) (standard)	130 dB(A) (standard)	130 dB(A) (standard)
Rec. mapping frequency	800 Hz – 25 kHz	400 Hz – 25 kHz	200 Hz – 25 kHz

Ring32 and Ring48 Array

Sphere48 and Sphere120 Array

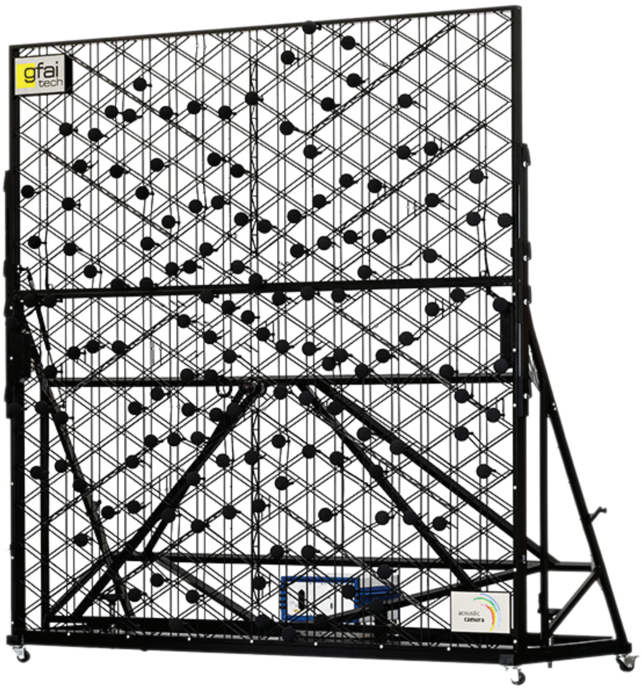
Sphere Array
for measurements in interiors.

Type	Sphere48	Sphere80	Sphere120
Microphone surface	Ø 0.35 m	Ø 0.6 m	Ø 0.6 m
Min. measurement distance	0.3 m	0.5 m	0.5 m
1/4" electret pressure microphones quantity	48	80	120
Maximum sound level	130 dB(A) (standard)	130 dB(A) (standard)	130 dB(A) (standard)
Rec. mapping frequency	400 Hz – 15 kHz	300 Hz – 10 kHz	300 Hz – 10 kHz

Star Array
for long-distance, low-frequency applications.

Type	**Star48**
Microphone surface	Ø 3.5 m
Min. measurement distance	5 m
1/4“ electret pressure microphones quantity	48
Maximum sound level	130 dB(A) (standard)
Rec. mapping frequency	100 Hz – 7 kHz

Star48 Array



Evo144 Array

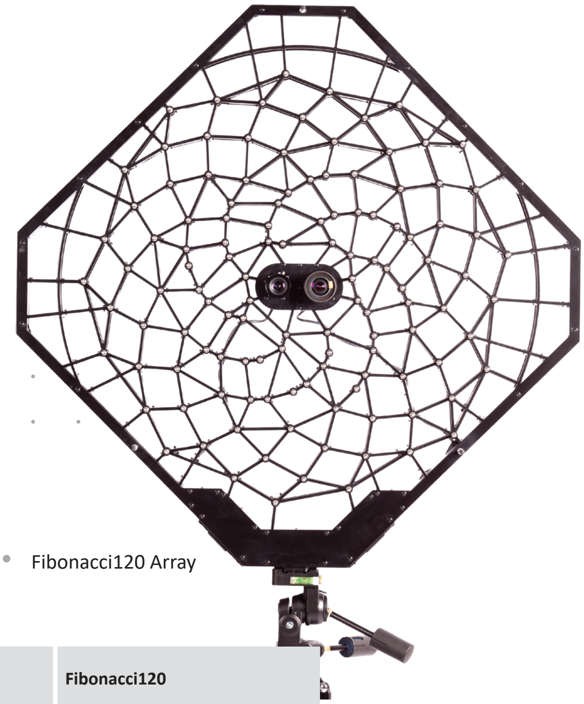
Evo Array
for aero-acoustic measurements.

Type	**Evo120**	**Evo144**	**Evo168**
Microphone surface	2.4 x 2.4 m	2.4 x 2.4 m	2.4 x 2.4 m
Min. measurement distance	2.5 m	2.5 m	2.5 m
1/4“ electret pressure microphones quantity	120	144	168
Maximum sound level	130 dB(A) (standard)	130 dB(A) (standard)	130 dB(A) (standard)
Rec. mapping frequency	200 Hz - 20 kHz	200 Hz - 20 kHz	200 Hz - 20 kHz

We also offer individual hardware solutions for your **wind tunnel**. In combination with the NoiseImage Wind Tunnel module we guarantee perfect results in the localization of aerodynamically created sources.

Individually configurable system.

Microphone Arrays.



Fibonacci120 Array

Fibonacci Array
for near and far field applications.

Type	Fibonacci72	Fibonacci96	Fibonacci120
Microphone surface	Ø 0.95 m	Ø 0.95 m	Ø 0.95 m
Min. measurement distance SONAH	10 cm	10 cm	10 cm
Min. measurement distance HELS	0 cm	0 cm	0 cm
Min. measurement distance Beamforming	0.8 m	0.8 m	0.8 m
1/4“ electret pressure microphones quantity	72	96	120
Maximum sound level	130 dB(A) (standard)	130 dB(A) (standard)	130 dB(A) (standard)
Rec. mapping frequency SONAH	40 Hz – 2 kHz	40 Hz – 2 kHz	40 Hz – 2 kHz
Rec. mapping frequency HELS	30 Hz – 400 Hz	30 Hz – 400 Hz	30 Hz – 400 Hz
Rec. mapping frequency Beamforming	300 Hz – 25 kHz	300 Hz – 25 kHz	300 Hz – 25 kHz

Paddle Array
for intensity mapping.

Type	Paddle2x24	Paddle2x52
Microphone surface	0.3 x 0.3 m	0.3 x 0.7 m
Rec. measurement distance	9 cm	9 cm
1/4“ electret pressure microphones quantity	48	104
Maximum sound level	130 dB(A) (standard)	130 dB(A) (standard)
Rec. mapping frequency	30 Hz – 2 kHz	30 Hz – 2 kHz

Paddle2x24 und Paddle2x52 Array

Custom 3-in-1 Array
for varying measurement tasks.

Type	Custom48	Custom72
Microphone surface	Ø 0.84 m	Ø 1.44 m
Min. measurement distance	0.5 m	0.75 m
1/4“ electret pressure microphones quantity	48	72
Maximum sound level	130 dB(A) (standard)	130 dB(A) (standard)
Rec. mapping frequency	400 Hz – 25 kHz	200 Hz – 25 kHz

Custom3-in-1 Array

Freeshape Microphone Bundle
for self-designed array geometries.

Type	Freeshape Bundle
Single microphone cable length	2.5 m (standard)
1/4“ electret pressure microphones quantity	24
Maximum sound level	130 dB(A) (standard)
Microphone frequency response	20 Hz – 20 kHz

Freely configurable 24 channel
microphone bundle (10Hz – 10kHz)

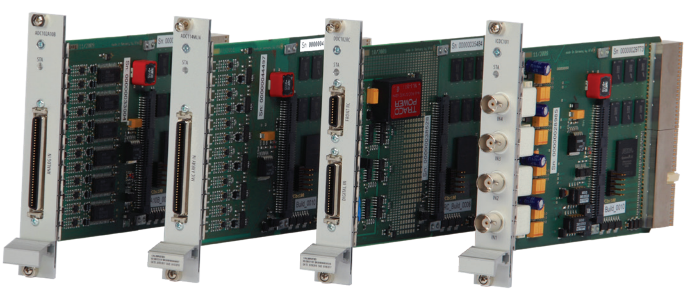
Individually configurable system.

Data Recorder.

Data Recorder mcdRec and Adapterbox ADCA100

Data Recorder mcdRec 721.

The **Acoustic Camera** data recorder was designed for high channel count applications in controlled environments or out in the field. Featuring a modular configuration it provides remarkably high data transfer rates for high temporal and spatial resolution.



Measurement cards

From left to right	Type of card	Number of channels	Input
1	cPCI Analog Measurement Card for microphone arrays	24 analog	diff. 2.5 ± 1 V
2	cPCI Analog Measurement Card for AC/DC measurements	8 analog	diff. ± 10 V
3	cPCI Analog Measurement Card for TEDS sensors, 30 bit adc	4 analog	4.7 mA / 1 to 23 V
4	cPCI Digital isolated Measurement Card with Remote Connector	12 digital	-7 V to + 12 V

Technical details mcdRec

- 24 to 168 microphone channels in a 10” rack (24 channels per card)
- Sampling frequency from 48 kHz to 192 kHz per analog channel, up to 6 MS/s
- CPU (Windows XP embedded)
- Network capability
- Gigabit Ethernet Interface, transfer rate up to 100 MByte/s
- Synchronization of several mcdRec
- Wide range power supply (90V – 240V)

100% autonomous handheld system.

Mikado.

Mikado
Easy and efficient troubleshooting.

The latest addition to the **Acoustic Camera** family features an easy to use and extremely efficient handheld device, usable 100% autonomously.

A Microsoft Surface running NoiseImage Mobile - the tablet version of our successful recording and post-processing software - guarantees ease of use while in the field. Data can be analyzed on the tablet directly or transferred onto a workstation running NoiseImage4.

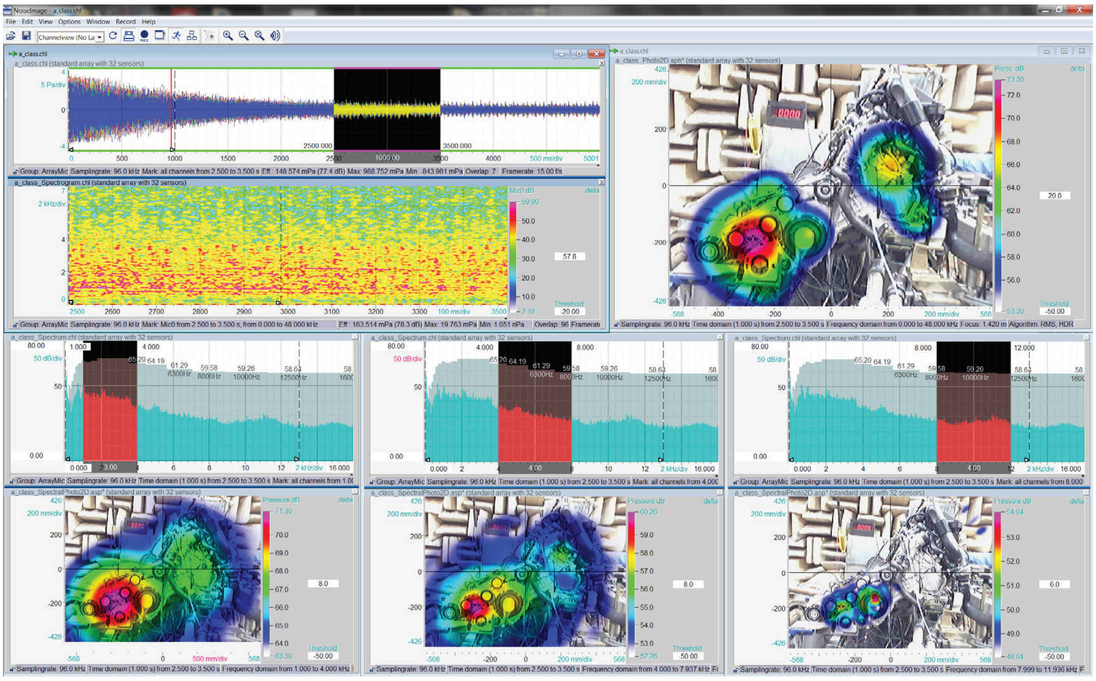
In battery-powered mode this **Acoustic Camera** will run for up to three hours.

Type	**Mikado**
Microphone surface	Ø 0.34 m
Min. measurement distance	0.3 m
Digital MEMS microphones quantity	96
Maximum sound level	121 dB(A)
Rec. mapping frequency	800 Hz – 24 kHz
Weight Handheld Handheld + Battery Handheld + Battery + Tablet	 1.7 kg 2.0 kg 3.4 kg
Dimensions (WxHxD)	0.45 x 0.35 x 0.15 m
Battery-powered mode	3 hours

Mikado with Microsoft Surface Pro 4

Individually configurable system.

Software NoiseImage.



NoiseImage enables you to perform a variety of analyses simultaneously: time-, frequency-, rpm- and space-selective.

Software NoiseImage: acquisition, evaluation and storage of data, acoustic images and movies.

During the development of NoiseImage, great attention was and is paid to ease of use, covering the important questions the user has to answer , as well as the overall quality and stability of the software. The straightforward and intuitive user interface is continuously enhanced. In-house knowledge from over 10 years of practical application paired with user feedback influence the development of NoiseImage and continuosly lead to new features and functionalities.

NoiseImage4 is based on a modular plug-in concept. Every module brings along its own graphical interface and tools. Decide for yourself which functions you really need and arrange a tailor-made software system.

Analysis methods and special features.

- Time-, frequency-, order-selective analysis
- Online capabilities (realt-time mode)
- A-, B-, C-standard weightings
- Freely configurable Butterworth filter bank
- Channel data export (e.g. ArtemiS, MATLAB®, .txt, .wav, UFF58)
- Export of Acoustic Photos and Movies to .txt, .jpg, .png, .bmp and .avi
- Location-selective listening mode (“virtual microphone” in 2D photo or 3D model)
- Linear and logarithmic scaling
- Different colour scale settings (delta, absolute, relative or manual)

acoustic **camera**

Measuring acoustic emissions from truck with Ring Array – set-up and 3D result.

Acoustic Movie 2D of a wind turbine and Acoustic Photo 3D of car interior including spectral analysis.

All modules of NoiseImage enable you to map onto 2D optical photo or 3D-model of the measured object

Acoustic Photo 2D/3D

- High resolution acoustic map (more than 20MPixel)
- Location-selective listening into the acoustic map
- Frequency-selective Acoustic Photo using band filter
- Frequency- and time-selective Acoustic Photo directly from selected region in the spectrogram
- Adjustable contrast of Acoustic Photos (colour palette and pressure- or dB-range)
- Export of Acoustic Photos to Text, JPG, PNG or BMP-format
- To AVI-Format in slow motion (without sound) and in realtime (including sound) in 2D and 3D

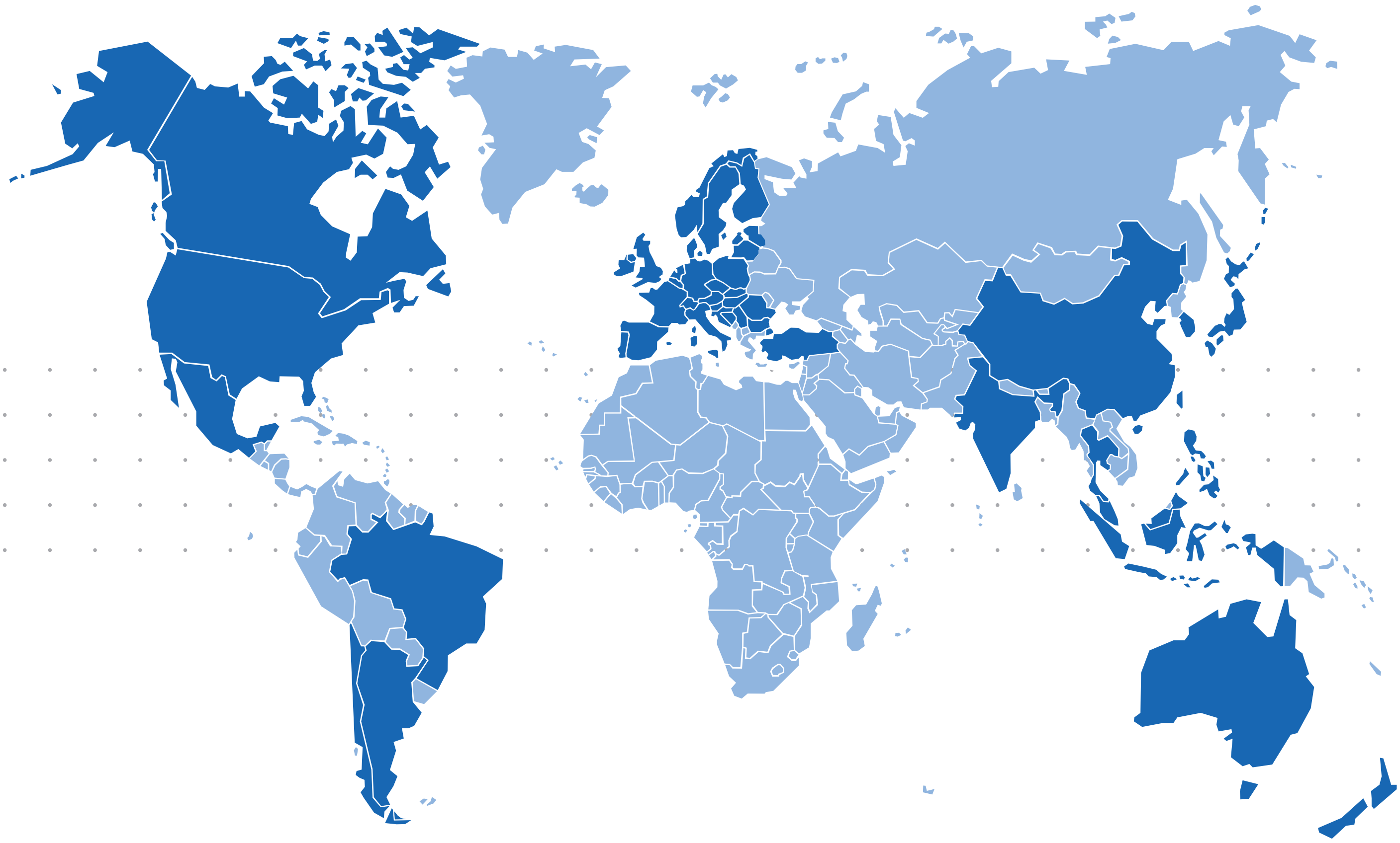
Acoustic Movie 2D/3D

- High time resolution, acoustic ultra slow motion up to several thousand acoustic frames per second
- Mapping of acoustic frames onto the recorded optical video (movie on movie-function)
- Location-selective listening into the Acoustic Movies
- Adjustable contrast of Acoustic Movies (colour palette and pressure- or dB-range)
- Export of individual frames from the Acoustic Movie to Text, JPG, PNG or BMP-format
- To AVI-Format in slow motion (without sound) and in realtime (including sound) in 2D and 3D

Spectral Photo 2D/3D

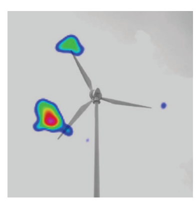
- Manual selection of a frequency band and immediate update of Photo2D and 3D
- Easy manipulation of the width of the selected frequency band using the mouse
- Continuous shifting of individually marked frequency band
- View of frequency and amplitude axis in linear as well as in logarithmic scalings
- Simple and fast visual evaluation of third octave bands
- Sound pressure level display for individual third octave bands
- Export of the Acoustic Photo to Text, JPG, PNG or BMP-format
- To AVI-Format in slow motion (without sound) and in realtime (including sound) in 2D and 3D

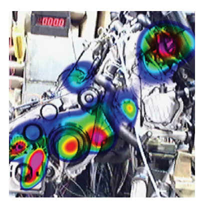
acoustic camera



For further information contact our local distributor:

www.acoustic-camera.com/en/contact





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