PRODUCT DATA

PULSE™ Array-based Noise Source Identification Solutions: Beamforming Type 8608, Acoustic Holography Type 8607 and Spherical Beamforming Type 8606

Noise Source Identification (NSI) is an important method for optimising the noise emission from a wide range of products from vehicles, white goods, power tools and heavy machinery to components like engines, tyres, gear-boxes, exhausts, etc.

The goal of NSI is to identify the most important sub-sources on an object in terms of position, frequency content and sound power radiation. Ranking of sub-sources can be used to identify where design changes will most effectively improve the overall noise radiation.

Array-based methods provide both the fastest measurement process and the highest quality of the results. The combination of acoustical holography with phased array methods gives accurate, high-resolution maps in the full audible frequency range.

Time-domain methods can be used to study transients like impacts and run-ups or to get detailed understanding of stationary sources, for example, noise radiation versus crank angle on engines. For large, stationary sources, an automated microphone positioning system (robot) can be used to measure automatically.

Hardware and Software

Software

- Spherical Beamforming Type 8606, providing a full 360 degree sound field map without making any assumptions about the sound field
- Acoustic Holography Type 8607, a method for mathematically describing the sound field based on a set of measurements
- Beamforming Type 8608, a method of mapping noise sources by differentiating sound levels based on the direction from which they originate
- All applications can post-process data
- Options available for all applications: Conformal; Transient; Quasi-stationary and Sound Quality Metrics Calculations
- Refined Beamforming Calculations for improved spatial resolution available as an option for Beamforming
- Road Vehicle and Rail Vehicle options for Beamforming
- Panel Contribution (patented method), Intensity Component Analysis and In Situ Absorption options for Acoustic Holography

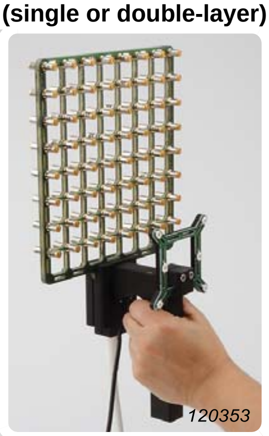
Arrays

- Grid arrays for scanned and general purpose measurements
- Patented arm wheel arrays, numerically optimised for acoustical performance in relation with beamforming
- Slice wheel arrays, numerically optimised for acoustical performance in relation to Beamforming and Acoustical Holography
- Hand-held array for real-time holography mapping, patch holography and conformal mapping using Statistically Optimised Near-field Acoustical Holography (SONAH, patent pending) and Equivalent Source Method (ESM)
- Spherical array for Beamforming even in confined environments
- Single signal cable system for connecting up to 132 channels via one socket

Selection of Arrays and Robots

Table 1 A selection of Brüel & Kjær's arrays and robots for fixed, path and scanned measurements

Spherical Array	Wheel Array (incl. camera)	Half-wheel Array	Grid Array
			
Applications: Vehicle and aircraft interior, building and industrial plants	**Applications:** General purpose (90-channel array typically used in automotive component applications)	**Applications:** Road vehicle and rail vehicle moving source beamforming including wind-tunnel and pass-by testing	**Applications:** General purpose, non-moving noise sources
NSI Method: Spherical Beamforming	**NSI Method:** Beamforming	**NSI Method:** Beamforming	**NSI Method:** Acoustic Holography and Transient Calculations
No. of Channels: 36 or 50	**No. of Channels:** 42 and over	**No. of Channels:** 42 and over	**No. of Channels:** 6 and over
Size: 20 cm diameter	**Size:** 0.65 m to 4.0 m diameter	**Size:** 1.5 m to 4.0 m diameter	**Size:** 0.125 m × 0.125 m and over (various spacing available)
Maximum Frequency: 12 kHz	**Maximum Frequency:** 20 kHz	**Maximum Frequency:** 10 kHz	**Maximum Frequency:** 6 kHz
Accessories: Tripod WQ-2691	**Accessories:** Tripod WQ-2691	**Accessories:** Carriage WA-0893	**Accessories:** Support Stand WA-0810 or Array Positioning System

Slice Wheel Array	Hand-held Array (single or double-layer)	2D Robot	Pentangular Array
			
Applications: General purpose, engines, automotive components/ interior, etc.	**Applications:** Components, interiors, etc.	**Applications:** From large, stationary noise sources, such as vehicles and engines, down to hearing aids and dentist drills	**Applications:** Outdoor noise sources, wind turbines, factories
NSI Method: Beamforming and Acoustic Holography	**NSI Method:** Real-time Holography, Patch Mapping and Conformal Calculations	**NSI Method:** Acoustic Holography	**NSI Method:** Beamforming, extraneous noise suppression
No. of Channels: 18, 36, 60 or 84	**No. of Channels:** min. 6 × 6 × 1, max. 8 × 8 × 2	**No. of Channels:** 2 to 96	**No. of Channels:** 30
Size: 0.35 m to 2.0 m diameter	**Spacing:** 25, 30, 35, 40 and 50 mm (size dependent on channel count and spacing)	**Size:** 1 m × 1 m up to 10 m × 3 m	**Size:** 3.5 m diameter
Maximum Frequency: – Beamforming 36-ch.: 6.0 kHz; 60-ch.: 8.0 kHz – Acoustic Holography 36-ch.: 1.5 kHz; 60-ch.: 1.2 kHz	**Maximum Frequency:** 6 kHz	**Maximum Frequency:** 12 kHz	**Maximum Frequency:** 5 kHz
			Minimum Frequency: 100 Hz
Accessories: Tripod WQ-2691	**Accessories:** 3D Creator Optical Sensor Positioning System WU-0695-W-001	**Accessories:** Integral Connection Array WA-0806, Flexible Connection Array WA-0807 and Robot Controller WB-1477	**Accessories:** Tripod WQ-2691

Noise Source Identification using Array-based Measurement Methods

To improve overall noise levels, it is necessary to locate, quantify and rank the individual noise sources coming from a machine. This starts by identifying 'hotspots' – areas where the local sound radiation is significantly greater than that of the surrounding area. Knowing these hotspots, the dominating frequencies and relative sound power contributions enable the cause of the noise to be identified and its contribution to the overall noise level to be assessed.

Traditionally, this has been done by mapping the sound intensity directly at a number of points across the source measured with an intensity probe. With array-based techniques, this process can be significantly improved as many points are acquired simultaneously, making measurements much faster. Brüel & Kjær provides a wide selection of arrays to cover most practical situations. The measurement types can be classified as:

- Fixed: The array is set-up and not moved during the measurements, for example, a pentangular array used to measure a wind turbine
- Patch: A grid array is moved from one position to another either manually or with a robot, for example, a hand-held array used for conformal mapping of a vehicle dashboard
- Scanned: A single, a row, or a full grid of microphones is scanned over a source by means of a robot, for example, used for measurements on stationary noise sources such as transformers or dentists' drills

Array Acoustics Post-processing to Optimise the Return on Measurement Data

The calculation, display and reporting of the measurement is done by the suite of products known as Array Acoustics, which includes Post-processing. The three main applications are Beamforming, Spherical Beamforming and Near-field Acoustical Holography (NAH). The applicability can be increased by adding one or more of the general options such as; Transient, Quasi-stationary, Conformal or Sound Quality Metrics Calculations. A number of options are specifically designed for use with a particular application, for example, Moving Source Options for Beamforming, and Panel Contribution for NAH.

Furthermore, in the calculations themselves, you can select from a range of algorithms to optimise this process, for example, NNLS and DAMAS2 for Refined Beamforming; SONAH and ESM for NAH.

Acoustic holography methods such as Statistically Optimized Near-field Acoustic Holography (SONAH) and Equivalent Source Method (ESM) are restricted in use to arrays with less than half wavelength average inter-element spacing. For a given array, this restriction defines an upper limit on the supported frequency range. To extend the frequency range, irregular "Combo Array" geometries are used for SONAH at low frequencies and for beamforming above the previously mentioned upper limiting frequency. A major drawback is the need for two methods to cover the full frequency range: a low-frequency measurement at close range for SONAH and a high-frequency measurement at longer distance for beamforming. The patented Wide Band Holography (WBH) method can cover the combined frequency ranges of SONAH and beamforming based on a single measurement at an intermediate distance (Fig. 1).

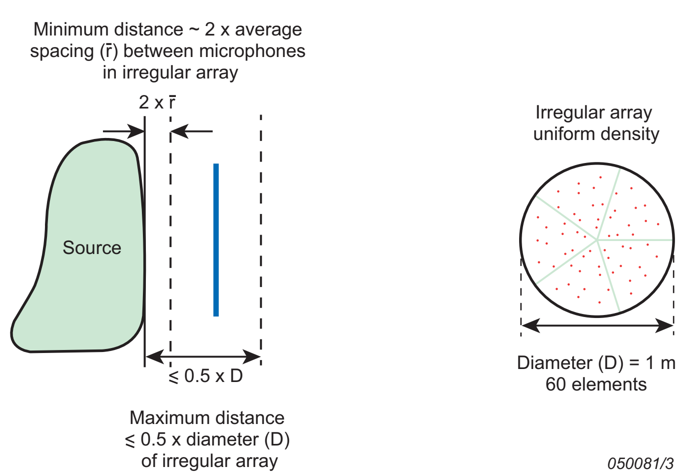


Fig. 1
The Wideband Holography patented method used to cover the combined frequency ranges of SONAH and beamforming, based on a single measurement at an intermediate distance

Near-field Acoustic Holography, NAH

NAH builds a mathematical model describing the sound field based on a set of sound pressure measurements typically taken in a plane fairly close to the source. From this description the parameters of the sound field, sound pressure, sound intensity, particle velocity, etc., can be derived in target planes parallel to the measurement plane.

The model can also be used to calculate far-field responses, estimating the sound pressure distribution along a line in the far-field based on the Helmholtz Integral Equation (HIE). Further potential noise reduction schemes can be applied to evaluate the impact of various source reduction possibilities. Two algorithms are available: Statistically Optimised Near-field Acoustic Holography (SONAH) and Equivalent Source Method (ESM).

The SONAH calculation method overcomes the limitations that traditional NAH calculation methods have, namely:

- The measurement area must cover the full noise source plus some additional area to avoid spatial window effects
- The measurement grid must be regular rectangular to support spatial FFT calculations

SONAH can operate with irregular arrays and allows for measurements with arrays smaller than the source, without severe spatial windowing effects.

The Equivalent Source Method (ESM) calculation can be used to deal with very curved surfaces, in that it can remove artefacts which SONAH can produce on non-plane surfaces. ESM is, therefore, implemented in Acoustical Holography when using Conformal calculations for the options Panel Contribution, Intensity Component Analysis and In Situ Absorption.

Measurement and Analysis

Stationary NAH measurements are typically made using a limited size grid array that is scanned over the source using a robot positioning system. To maintain an absolute phase reference between scan positions, a set of reference signals is simultaneously acquired. Transient measurements are typically performed using large fixed arrays, as all measurement positions must be acquired simultaneously.

Performance

- **Resolution:** The resolution, defined as the shortest distance at which two point sources can be separated, is approximately equal to:
  $R = \min(L, \lambda/2)$
  where L is the distance from array to source and λ is the wavelength
- **Frequency Range:** The frequency range is determined by:
  $f_{max} = c/2dx$ and $f_{min} = c/8D$
  where c is the speed of sound, dx is the average spacing between measurement points and D is the diameter of the array

The use of NAH is, therefore, limited at high frequencies by the spacing between measurement points. Typically NAH can be used from 50 Hz to 3000 Hz.

Features and Benefits

- Easy, high-resolution mapping at low and mid frequencies
- Very low f_{min} using SONAH or ESM
- Fully automated data acquisition including robot control using PULSE Acoustic Test Consultant Type 7761

Typical Applications

- Contribution analysis
- Engines and powertrains
- Components
- Door seal leakage
- Office machinery
- White goods
- Heavy machinery

Application Examples

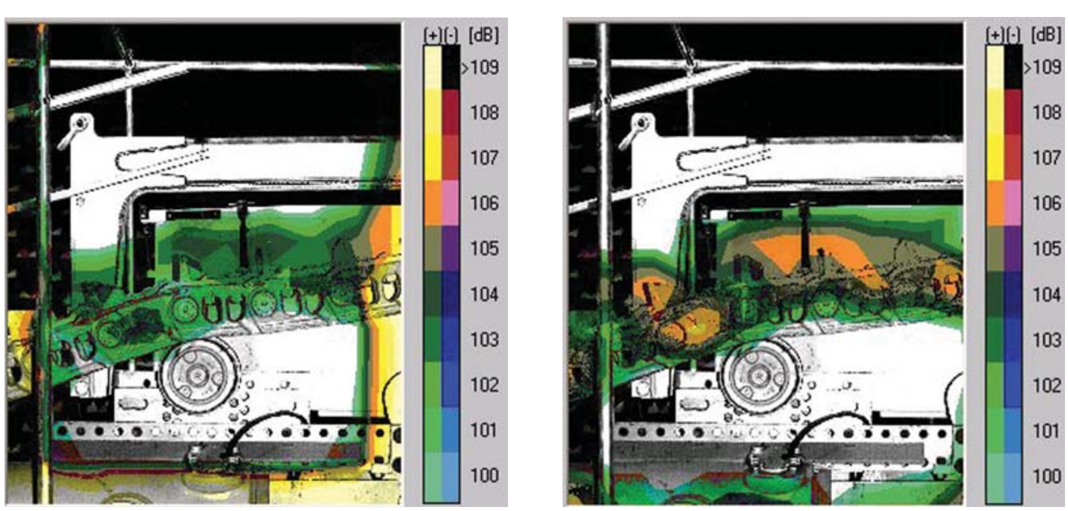
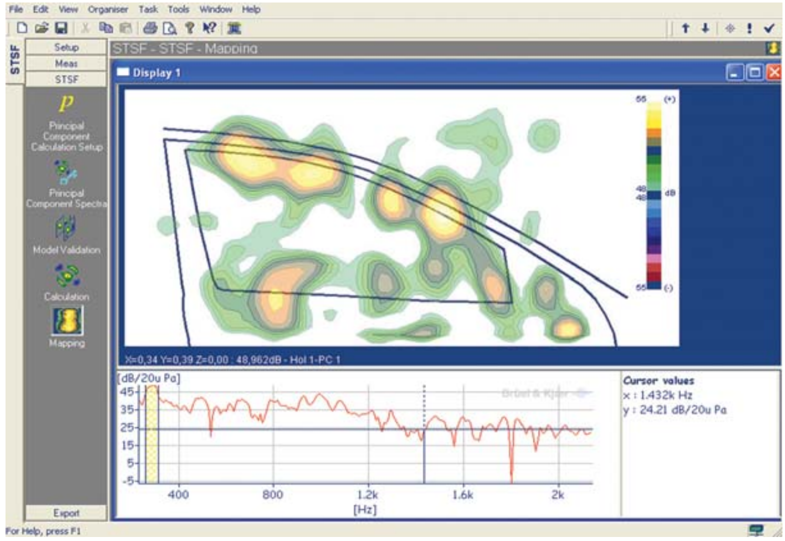


Fig. 2
Averaged particle velocity maps for the 1/12-octave bands 205 – 1454 Hz, A-weighted.
Left: *NAH*
Right: *SONAH. Note how SONAH reduces the edge effects*

Fig. 3
Map of door seal leakage. Acoustical Holography calculations provide high-resolution mapping by calculating results in a plane close to the source surface



Planar Beamforming

Beamforming is a method of mapping noise sources by differentiating sound levels based on the direction from which they originate. The method is very quick, allowing a full map to be calculated from a single-shot measurement. It also works at high frequencies. Innovative Brüel & Kjær wheel arrays can be used with PULSE Beamforming to produce acoustically optimal results while maintaining maximum ease of use and handling.

Compared to other source location methods, the beamforming method is quick since all channels are measured simultaneously. This optimises the use of expensive measuring facilities such as anechoic chambers and wind tunnels, and takes away the tediousness and repetitiveness of many traditional methods.

Where the object under test can be considered to be composed of non-coherent sources, the Refined Beamforming algorithms based on deconvolution can be used to improve the spatial resolution of the noise maps by a factor of three or more.

Measurement and Analysis

The sound field radiating from the test object is measured at a number of microphone positions at some distance from the object. The microphones are arranged in a planar array facing towards the centre of the object.

By introducing a specific delay on each microphone signal and adding the result, it is possible to computationally create an acoustical antenna equivalent to a parabolic reflector with a main lobe of high sensitivity along a certain angle of incidence. By repeating the calculation process on the same set of measured data for a large number of angles, a full map of the relative sound pressure contribution at the observation point can be generated. With Beamforming, results can be calculated to within an angle of up to 30° away from the centre axis so that even small arrays can map large objects. It is, for example, possible to map a full vehicle from just one measurement position.

Array Design

The dynamic range (also known as the Maximum Side Lobe (MSL) level) of the maps will typically be between 8 and 15 dB depending on the design of the array. In general, irregular arrays outperform traditional regular array designs, but even irregular arrays with the same number of microphones may have very different performance depending on the exact position of the microphones. Brüel & Kjær uses a patented numerical optimisation method to design arrays with optimal performance for the frequency range and number of microphones.

The special sliced wheel array design is optimised to perform with both Beamforming and Acoustical Holography and can, therefore, be used with a combination of the methods to provide mapping of the full audible frequency range.

Performance

- **Resolution:** Defined as the shortest distance at which two point sources can be separated, is approximately equal to:
  $R = L/D * \lambda$
  where: L is the distance from array to source, D is the size of the array, and λ is the wavelength

The use of Beamforming is, therefore, limited at low frequencies by resolution. Typically Beamforming can be used from 500 Hz to 20 kHz.

For large sound sources outdoors, such as wind turbines and factories, a pentangular array is recommended. This funnel shaped array enables extraneous noise from the rear of the array to be suppressed up to 10 dB (depending on the frequency).

For road and rail vehicles, the dedicated Moving Source Beamforming Option has been developed.

Features and Benefits

- Quick snapshot measurements
- Ideal for mid and high frequencies
- Covers large objects
- May, in combination with SONAH, cover the full audible frequency range

Typical Applications

- Contribution analysis
- Machinery
- Construction equipment
- Wind tunnels
- Engines and powertrains
- Components
- Seals
- Vehicle interiors

Application Example

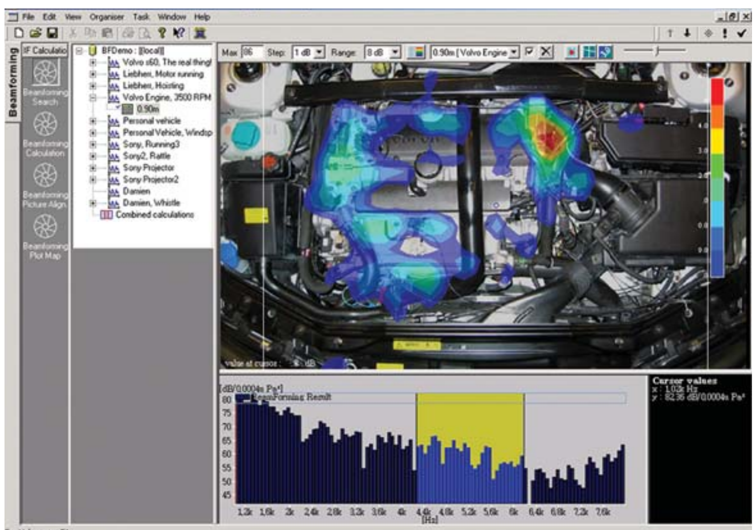


Fig. 4
Beamforming result on a car engine

Conformal Mapping

A completely conformal map can be created based on a set of patch measurements at known positions and object geometry. The object geometry can either be imported from a number of standard formats or detected using the position detection system integrated in the hand-held array.

Object Geometry

Replacing the microphone array with a pointer, the positioning system in the hand-held array's handle registers the 3D coordinates of the most significant points of the geometry. Meshing tools can then be used to refine the object geometry to a suitable granularity depending on the resolution required. Alternatively, the object geometry can be imported from existing CAD or CAE models, in which case a reduction of the model is usually required in order to minimise the number of elements, and thereby the number of measurement points. CAD surface models can be imported via the IGES file format (file extension .igs) or surface mesh models via the Universal File Formats 2411 and 2412 (file extension .unv).

In general, IGES file format types 143 and 144, as well as the 500 series (also called B-Rep) can be imported. STL and UFF files can also be imported.

Measurement and Analysis

Measurements with the hand-held array are made at the most accessible places around the object, with 36 to 128 points typically measured simultaneously. Based on the integrated positioning system, the software keeps track of the positions measured. Typically the number of measurement points should correspond to the maximum frequency.

Features and Benefits

- Accurate mapping of non-planar objects
- High mapping resolution – even at low frequencies
- Measurements can be taken at the most accessible places
- No complicated array support structure needed
- No previous modelling required

Typical Applications

- Contribution analysis
- Components
- Subassemblies
- Seals
- Vehicle interiors

Application Example

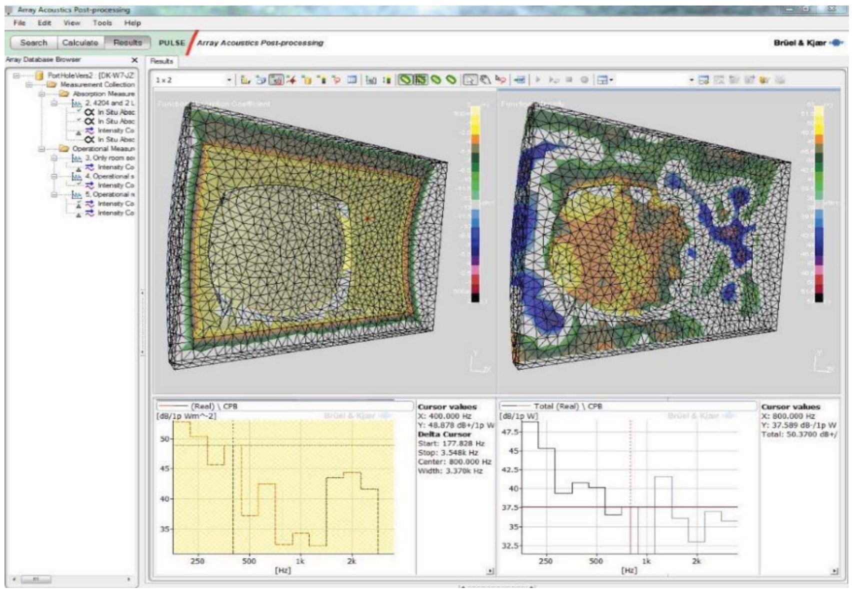


Fig. 5
Conformal mapping of an aeroplane porthole: ***Left****: The averaged absorption averaged over the various areas.* ***Right****: The intensity map.* ***Graph on left****: Intensity spectrum for a particular point;* ***Graph on right****: Sound power spectrum for whole porthole*

Spherical Beamforming

Spherical Beamforming offers two calculation algorithms: an algorithm called Spherical Harmonics Angularly Represented Pressure (SHARP) and a Filter and Sum algorithm (FAS, patent pending). Both provide a complete omnidirectional noise map in any acoustic environment based on one simple measurement. Unlike other methods that only map part of the surroundings, Spherical Beamforming uses a spherical array to map noise in all directions while 12 cameras mounted in the sphere automatically take pictures in all directions. At display time, these images are used as the background for the acoustic map.

In addition, Spherical Beamforming does not make any assumptions about the nature of the acoustic environment and can, therefore, be used in both free-field and reverberant surroundings. For these reasons, Spherical Beamforming is commonly used to make overview maps in confined and semi-damped spaces such as vehicle and aircraft cabins.

Measurement and Calculation

The measurement is performed using an array of microphones mounted on the surface of a hard sphere. The microphone positions on the sphere are numerically optimised to maximise the dynamic depth of the map. The sphere is usually placed at a typical impact position, for example, in the driver’s seat of a vehicle.

The SHARP calculation decomposes the observed sound field into its spherical harmonic components and then estimates the directional contributions by recombining these spherical harmonics.

The FAS calculation takes the output from each microphone and applies a FIR filter which is optimised for each angle of incidence to minimise the side lobes for the sphere. The resultant pressures are then summed to yield an acoustical map.

Performance

The angular resolution of the SHARP and FAS algorithms used for Spherical Beamforming is roughly the same. However, FAS provides considerable development in MSL.

Table 2*:*
Resolution (– 3 dB), in degrees, for a sphere with a radius of 10 cm

Spherical Beamforming								
200 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	6000 Hz	8000 Hz	10 kHz	12 kHz
105	65	48	32	24	16	13	10	8

The error-free dynamic range (Maximum Side Lobe (MSL) level) decreases with frequency. With SHARP, for the 50-channel array, the MSL is better than 6 dB up to 8 kHz, and for the 36-channel array, better than 6 dB up to 5 kHz. For FAS, the MSL is greatly improved yielding better than 6 dB up to 12 kHz for the 50 channel array, and better than 6 dB up to 8 kHz for the 36 channel array.

The band of use of Spherical Beamforming is set, therefore, at low frequencies by the angular resolution and at the high frequencies by the MSL, with a range from 250 Hz to 12000 kHz.

For measurements inside vehicles, Spherical Beamforming is typically used to give an overview of the acoustics. For more detailed information, particularly at low frequencies, a hand-held array can be used together with Conformal Acoustical Holography, thus covering a very wide frequency range.

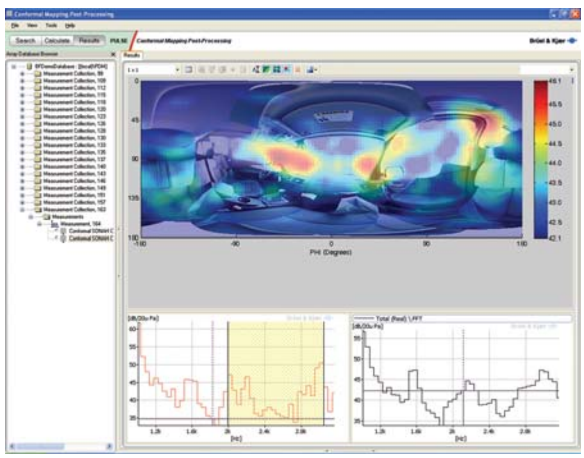
Features and Benefits

- Quick snapshot measurement
- Ideal for mid to high frequencies
- Omnidirectional coverage
- Independent of acoustic environment

Typical Applications

- Vehicle interior noise
- Aircraft cabin noise
- Rooms
- Industrial plant noise

Application Example



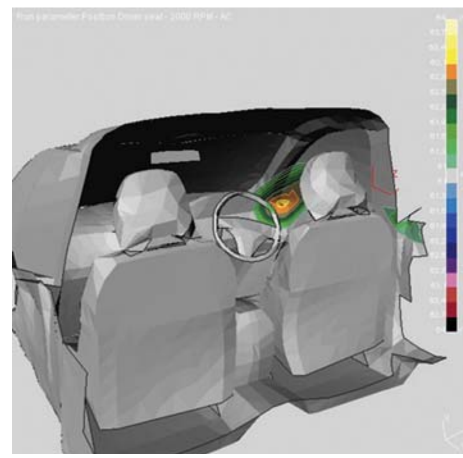


Fig. 6
Left: *Omnidirectional result from a road test using Spherical Beamforming. The car interior at 80 mph: 2000 – 3000 Hz*
Right: *Conformal mapping result from a test on a car using a Spherical Array directed towards the driver's seat (with air conditioning running). The result shows the right vent making more noise than other vents, (1/3-octaves, 4 – 5 Hz)*

Sound Quality Metrics BZ-5638

For all the array applications (Beamforming, Acoustic Holography, Spherical Beamforming), sound quality metrics can be mapped, see the examples in Fig. 7.

Fig. 7
Comparison of loudness and SPL maps, 15.5 –18 bark
Left: *Stationary loudness*
Right: *Sound pressure*

The sound quality metrics that are available to the user depend on the processing type selected in the Array Acoustics Suite, see Table 3. The metric *Impulsiveness* was developed in partnership with Isuzu Motors Limited in Japan.

Table 3
Sound Quality metrics available

	Processing Types in Array Acoustics Suite			
	Stationary	**Quasi-stationary**	**Transient**	**Sound Quality Metrics**
Stationary Loudness	●	●		●
Non-stationary Loudness			●	
Sharpness	●	●		●
Statistical Loudness				●
Roughness				●
Fluctuation Strength				●
Articulation Index	●	●		●
Psychoacoustic Annoyance				●
Loudness Level	●	●	●	●
Combined Metrics				●
Impulsiveness				●

Typical Setups for Array Systems

Fig. 8
Typical 18-channel Slice Wheel Array system

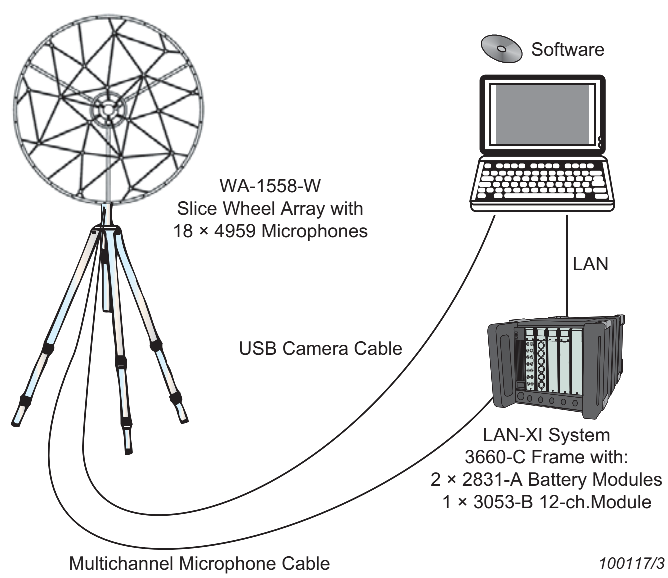
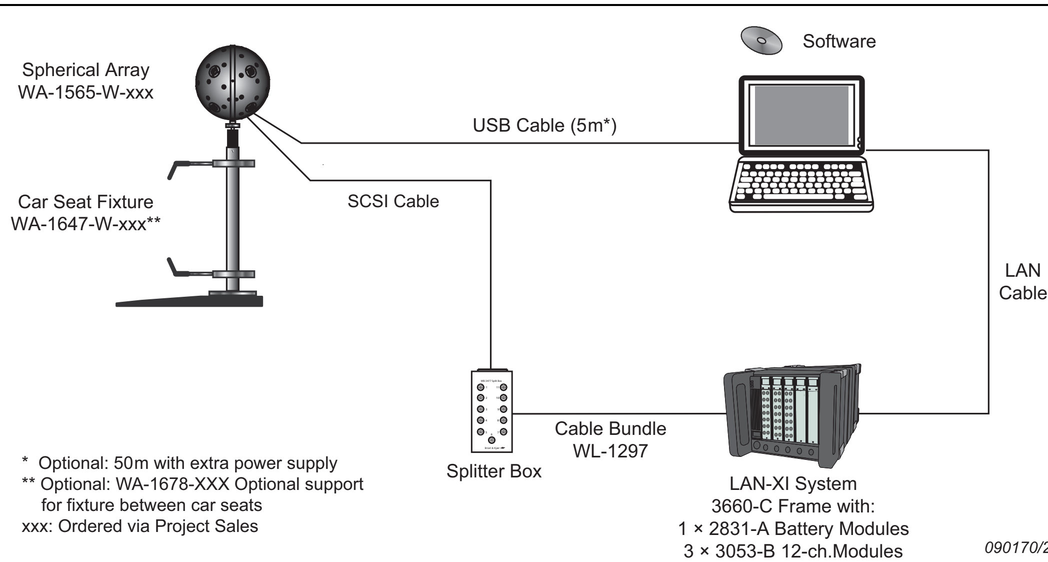


Fig. 9
Typical 36-channel system for spherical beamforming. Spherical beamforming systems are supplied as customer-specified projects



* Optional: 50m with extra power supply
** Optional: WA-1678-XXX Optional support for fixture between car seats
xxx: Ordered via Project Sales

Fig. 10
Typical Pentangular Array system

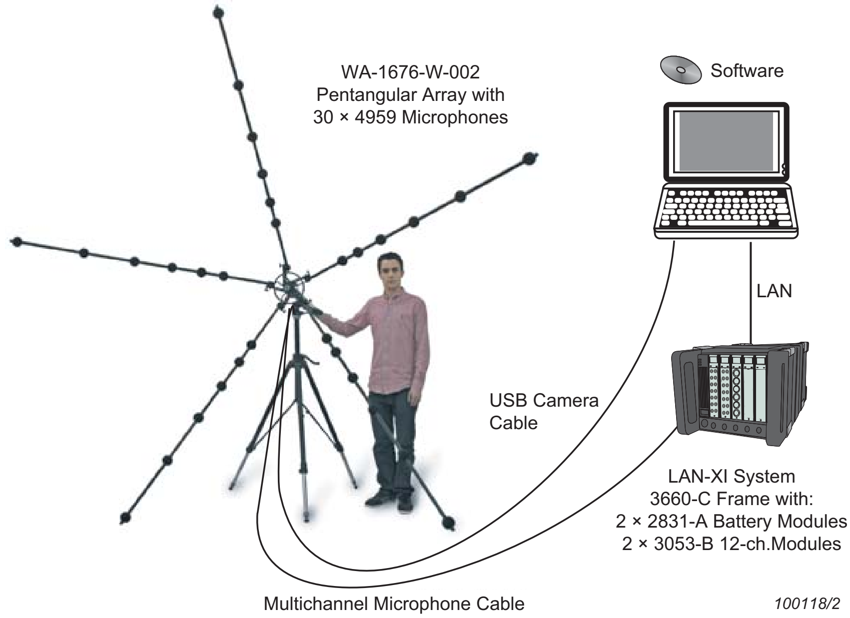
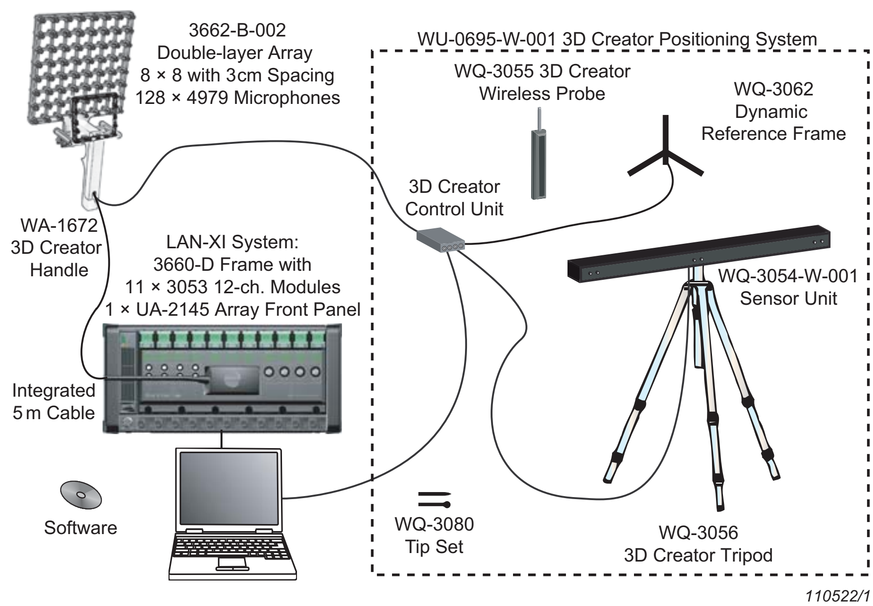


Fig. 11
Typical Hand-held Double-layer Array system with Array Front Panel UA-2145 with single cable for all acoustic signals



Hand-held Arrays – Frequency Ranges

Hand-held Array Type	Layer	Configuration	Grid Spacing (mm)	Mics. Required	Array Length (m)	Typical Min. Frequency (Hz)	Typical Max. Frequency (Hz)
Type 3662-A-001	Single	8 × 8 × 1	25	64	0.175	245	6174
Type 3662-A-002	Double	8 × 8 × 2	25	128	0.175	245	4979
Type 3662-A-003	Single	6 × 6 × 1	25	36	0.125	343	6174
Type 3662-A-004	Double	6 × 6 × 2	25	72	0.125	343	4979
Type 3662-B-001	Single	8 × 8 × 1	30	64	0.210	204	5145
Type 3662-B-002	Double	8 × 8 × 2	30	128	0.210	204	4979
Type 3662-B-003	Single	6 × 6 × 1	30	36	0.150	286	5145
Type 3662-B-004	Double	6 × 6 × 2	30	72	0.150	286	4979
Type 3662-C-001	Single	8 × 8 × 1	35	64	0.245	175	4410
Type 3662-C-002	Double	8 × 8 × 2	35	128	0.245	175	4410
Type 3662-C-003	Single	6 × 6 × 1	35	36	0.175	245	4410
Type 3662-C-004	Double	6 × 6 × 2	35	72	0.175	245	4410
Type 3662-D-001	Single	8 × 8 × 1	40	64	0.280	153	3859
Type 3662-D-002	Double	8 × 8 × 2	40	128	0.280	153	3859
Type 3662-D-003	Single	6 × 6 × 1	40	36	0.200	214	3859
Type 3662-D-004	Double	6 × 6 × 2	40	72	0.200	214	3859

Configuration

OPERATING SYSTEM REQUIREMENTS
Microsoft® Windows® 8 Pro (x64), Windows® 7 SP1 (x32 and x64) or Windows® XP Professional (SP3)

OTHER SOFTWARE REQUIREMENTS
Microsoft® Office 2007 (SP2), Office 2010 (SP2) x32, or Office 2013 (x32)
Microsoft® SQL Server® 2008 R2 Express Edition (SP 1), included with PULSE)

COMPUTER CONFIGURATION/DATA ACQUISITION FRONT-ENDS
As for PULSE

PREREQUISITES
- PULSE 7700, 7770, or 7771
- PULSE Acoustic Test Consultant Type 7761

One of:
- PULSE LAN-XI and IDA^e/IDA Multiple Module Front-end Driver Type 3099-A-X*
- PULSE LAN-XI Single Module and IDA^e/IDA Systems any size Front-end Driver Type 3099-A-X1*
- PULSE LAN-XI Dual Module and IDA^e/IDA Systems any size Front-end Driver Type 3099-A-X2*

* X = the license model, either N: Node Locked or F: Floating

	Acoustic Holography Type 8607	Beamforming Type 8608	Spherical Beamforming Type 8606
Measurement			
Monitor view	Yes	Yes	Yes (for single camera)
Data	Time or Spectral	Time	Time
Process	Single, Patch or Scanned	Single	Single
Optical picture	N/A	Take or reuse	Take or reuse
Automatic processing	Store automatically, Calculate automatically, Selectable calculation	Store automatically, Calculate automatically, Selectable calculation	Store automatically, Calculate automatically, Selectable calculation
Data Management			
Databases	Multiple simultaneous	Multiple simultaneous	Multiple simultaneous
Inspect metadata	Yes	Yes	Yes
Search on metadata	Yes	Yes	Yes
Change metadata	Yes	Yes	Yes
Calculation			
Multi core support	Yes	Yes	Yes
Target mesh type	Planar, Conformal	Planar, Conformal	Spherical, Conformal
References	Physical and Virtual	Physical	Physical
Methods	NAH, SONAH, ESM	Delay and Sum, Refined NNLS, DAMAS 2	SHARP, FAS
Filtering	Frequency, Order	Frequency, Order	Frequency, Order
Domains	Stationary, Quasi-stationary, Transient	Stationary, Quasi-stationary, Transient	Stationary, Quasi-stationary, Transient
Function	Pressure, Intensity, Reactive Intensity, Particle Velocity, Front Source Intensity, Rear Source Intensity, Scattered Intensity, Radiated Intensity, Absorption Coefficient	Pressure Contribution, Pressure, Intensity	Pressure Contribution, Pressure, Intensity
Index dimensions	Time, RPM, Angle	Time, RPM, Angle	Time, RPM, Angle
User Interface			
User levels	Basic and Advanced User defined	Basic and Advanced User defined	Basic and Advanced User defined
Defaults	User defined	User defined	User defined
Contribution Analysis			
Sound Power	Area, Component	Area, Component	Area, Component
Map Displays			
Number of displays	1 × 1 to 4 × 4	1 × 1 to 4 × 4	1 × 1 to 4 × 4
Alignment of displays	Camera Position, Data, Frequency, Index, Colour scale	Camera Position, Data, Frequency, Index, Colour scale	Camera Position, Data, Frequency, Index, Colour scale
Playback	Calculated Points	Calculated Points	Calculated Points
Reporting			
Cut and Paste	One view, All views	One view, All views	One view, All views
Movie file generation	Animation driven Audio driven	Animation driven Audio driven	Animation driven Audio driven
Microsoft® Word report generator	Across frequencies Across indices	Across frequencies Across indices	Across frequencies Across indices
Capacity			
Calculation*	Stationary (frequency based): • 2000 measurement points • 2000 target points • 6 references • 400 line FFT Stationary (time based): As Type 8608	Stationary (time based): • 300 s at 12.8 kHz • 60 measurement points • 8000 target points • 800 line FFT (or equivalent)	Stationary (time based): • 300 s at 6.4 kHz • 800 lines FFT • 2592 target points (spacing 5° in azimuth and elevation)

	Acoustic Holography Type 8607	Beamforming Type 8608	Spherical Beamforming Type 8606
Calculation*	Transient: • 300 s at 12.8 kHz • 60 measurement points • 400 target points • 300 frames • 800 line FFT (or equivalent)†	Transient: • 300 s at 12.8 kHz • 60 measurement points • 400 target points • 300 frames • 800 line FFT (or equivalent)†	Transient: • 300 s at 12.8 kHz • 50 measurement points • 400 target points • 300 frames • 800 line FFT (or equivalent)
Measurement	Frequency Data: • Set by PULSE FFT analyzer (Type 3560-B/C/D/E with Type 7700 or 7770) • 2000 measurement points • 6 references • 400 line FFT Time Data: As Types 8606 and 8608	Time Data: • 300 s at 12.8 kHz • Set by data recorder (Data Recorder Type 7701 or Time Data Recorder Type 7708)	Time Data: • 300 s at 12.8 kHz • Set by data recorder (Data Recorder Type 7701 or Time Data Recorder Type 7708)

* For one parameter at a time (for example, sound pressure, sound intensity)
† Full compliance with specification with Windows® 64-bit. With Windows® 32-bit, the specification is halved

Ordering Information

Type/Part No.	Name	Acoustic Holography Type 8607	Beamforming Type 8608	Spherical Beamforming Type 8606
8606-X*	PULSE Array Acoustics Spherical Beamforming	–	–	Required
8607-X*	PULSE Array Acoustics Acoustic Holography	Required	–	–
8608-X*	PULSE Array Acoustics Beamforming	–	Required	–
BZ-5644-X*	PULSE Array Acoustics Wideband Holography	–	Option	–
BZ-5635-X*	PULSE Array Acoustics Quasi-stationary Calculations	Option	Option	Option
BZ-5636-X*	PULSE Array Acoustics Transient Calculations	Option	Option	Option
BZ-5637-X*	PULSE Array Acoustics Conformal Calculations	Option	Option	Option
BZ-5638-X*	PULSE Array Acoustics Sound Quality Metrics	Option	Option	Option
BZ-5639-X*	PULSE Array Acoustics Refined Beamforming Calculations	–	Option	–
BZ-5943-X*	PULSE Array Acoustics Road Vehicles Moving Source Beamforming	–	Option	–
BZ-5939-X*	PULSE Array Acoustics Rail Vehicles Moving Source Beamforming	–	Option	–
BZ-5941-X*	PULSE Array Acoustics Wind Turbines Moving Source Beamforming	–	Option	–
BZ-5640	PULSE Panel Contribution	Option†	–	–
BZ-5641	PULSE Intensity Component Analysis	Option†	–	–
BZ-5642	PULSE In Situ Absorption	Option†	–	–
BZ-5370	PULSE ATC Robot Option	Option	–	–
BZ-5611	PULSE ATC Positioning Option	Option	–	–
7761-X*	PULSE Acoustic Test Consultant	Prerequisite	Prerequisite	Prerequisite
7700/7770/7771-Xy*, ‡	PULSE FFT & CPB/FFT/CPB	Prerequisite	Prerequisite	Prerequisite
3099-A-X/X1/X2**	Front-end Driver	Prerequisite	Prerequisite	Prerequisite

* X = license model either N for node-locked or F for floating
† requires PULSE Array Acoustics Conformal Calculations BZ-5637-X
‡ y = optional channel count, from 1 (single) to 7. No number denotes unlimited channels (channel-independent)
** See PREREQUISITES on page 11

ACCESSORIES

Type 9665	Array Positioning System (Robot)
UA-2145	Array Front Panel for LAN-XI 11 modules
WA-0810	Support Stand for Grid Array
WA-0806	Integral Connection Array
WA-0807	Flexible Connection Array
WB-1477	Robot Controller
WU-0695-W-001	3D Creator Optical Sensor Positioning System
WA-1565-W-003	Spherical Array for 36 Channels
WA-1565-W-004	Spherical Array for 50 Channels
WA-1647-W-001	Car Seat Fixture for Spherical Array
WA-0728-W-004	Single-channel Pistonphone Adaptor, stethoscope, for Spherical Array with Microphones Type 4959
WA-0728-W-005	Single Channel Pistonphone Adaptor, stethoscope version for foldable array with Type 4959
WA-0890	Full wheel/Half-wheel Beamforming Array
WA-1558	Slice Wheel Array
WQ-2691	Tripod
WA-0893	Carriage for Half-wheel Array
Type 3662-X-yyy*	Hand-held Array (see Table 1)
Type 4957	10 kHz Array Microphone
Type 4958	20 kHz Precision Array Microphone
Type 4959	10 kHz Very Short Array Microphone

* X = A, B, C or D, which is standard spacing at 25, 30, 35 or 40 mm; yyy = 001, 002, 003 or 004, which are channel counts at 8×8×1, 8×8×2, 6×6×1 or 6×6×2

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