PRODUCT DATA

PULSE Array Acoustics, Road Vehicles Moving Source Beamforming BZ-5943

PULSE™ LabShop > PULSE Array Acoustics, Beamforming Type 8608 > Option BZ-5943

Road Vehicles Moving Source Beamforming BZ-5943 is an option for PULSE Array Acoustics, Beamforming Type 8608, an array-based noise source identification (NSI) application for PULSE LabShop.

Beamforming is a method of mapping noise sources by using an array of microphones to detect the direction of arrival of sound from the sources to the array.

BZ-5943 follows linear movement parallel to a planar array of microphones and enables speed-position calculation from a radar signal, GPS or photocells. The option also enables displays of mapping versus position and pressure contribution versus position and frequency at the same time.

Uses and Features

Uses

- Troubleshooting contribution during pass-by measurements
- Locating noise sources radiating from moving vehicles, for example, cars or lorries
- Mapping planes from the side, front and top of the target vehicle
- Mapping higher frequencies than standard noise source location methods
- Analysing component pressure contribution

Features

- Outward-looking array – maps targets much larger than itself
- Noise mapping versus source position or averaged map
- Automatic Doppler correction
- Linear and A-weighted sound maps
- AVI file format for presentations and reports

How Moving Source Beamforming Works

Beamforming

The sound field radiating from a test object is measured using a planar array of microphones at some distance from the object facing towards the centre of the target area. By introducing a specific delay to 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 particular 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.

The beamforming algorithm works in both a free-field mode and a mirror-ground mode. In the mirror-ground mode, a totally reflective ground plane is assumed to be in a known position relative to the array.

Beamforming Arrays

Apart from the main lobe, any beamforming array will also have a number of undesired side lobes. If these are not well attenuated compared to the main lobe, they can (particularly in narrow-band results) lead to unreal ‘ghost’ images in the final map. The patented Brüel & Kjær arrays suppress ghost images by numerically optimizing the microphone positions to give a high side-lobe attenuation over a wide frequency range.

Brüel & Kjær

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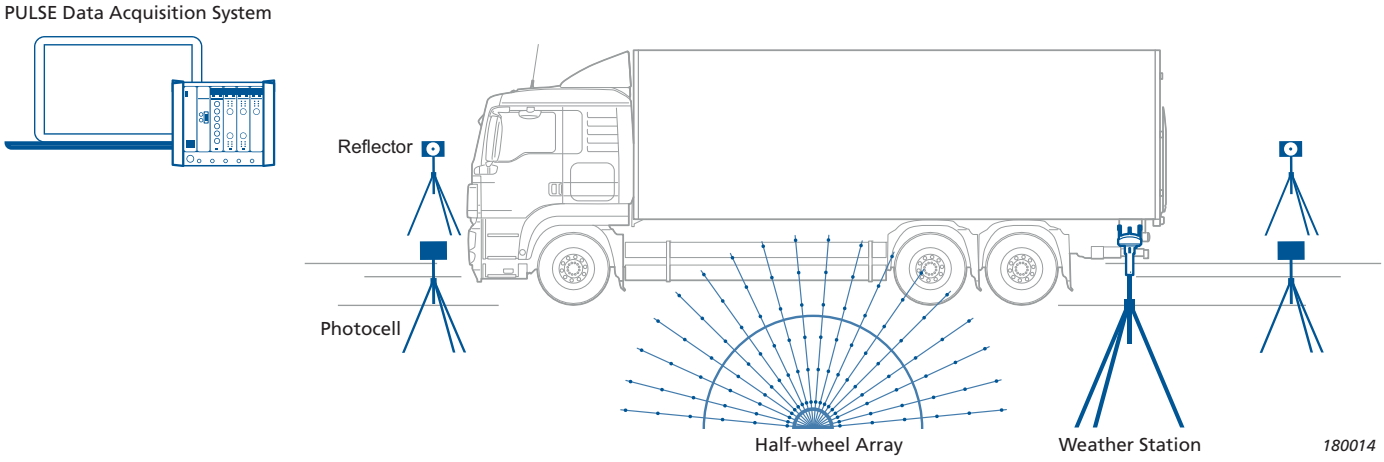
To apply the beamforming algorithm to a moving source, the introduced time delays are continuously adjusted to, in effect, track the moving target. BZ-5943 tracks the vehicle and continuously adjusts the focus point to compensate for the Doppler effect.

System Overview

The test area is set up on a straight stretch of road. The hardware typically used consists of a data acquisition system (measurement and analysis software plus data acquisition hardware), a planar array and at least one photocell/reflector. Weather stations are supported, but optional.

Fig. 1 *Typical setup for Road Vehicles Moving Source Beamforming*



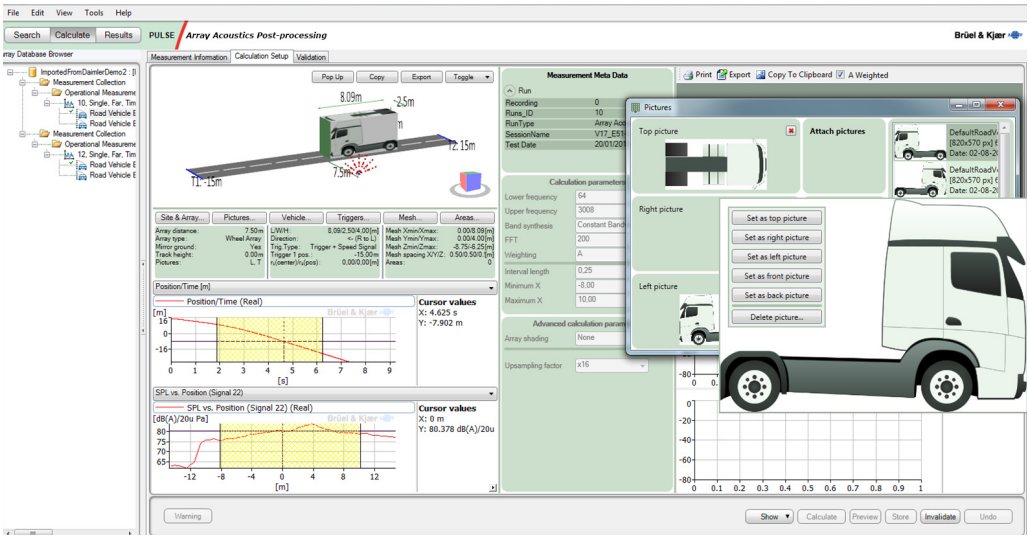
Positioning

Vehicle dimensions and pictures are entered in the Calculation Setup. The data acquisition system functions according to the relationship between the global coordinates (the test area) and the local coordinates (the vehicle). Results are expressed in terms of the local coordinate system.

Moving Source Beamforming offers several methods to detect position and speed:

- **Position Trigger and Speed Pulses** – for detection of varying speed, using photocells, radar or GPS
- **Position Trigger and Manually Set Speed** – for fixed-speed detection, using a single photocell
- **Dual-position Triggers** – for fixed-speed detection using two photocells

Fig. 2
Calculation Setup in Array Acoustics Post-processing showing position of vehicle on test track, the position of the half-wheel array and the images to be used when displaying the results



Processing

BZ-5943 utilises up-sampling rather than unnecessarily devouring massive amounts of data storage space. For example, measurements recorded with 8192 samples/s are up-sampled by a factor of 16. This method produces less than 10% phase error at 3 kHz (or <0.1 dB error). Not only does up-sampling save storage space, but it simplifies setup and incurs negligible error.

Measurements

Measurement intervals are user-defined. For pass-by, measurements are typically taken every 25 cm. Time data is stored as a function of displacement for each calculation point in the sound map. Post-processing is performed using PULSE Beamforming Type 8608 in the Array Acoustics Post-processing application. The acoustical signals, the engine speed, the position of the vehicle on the track, etc., can be checked (Fig. 3).

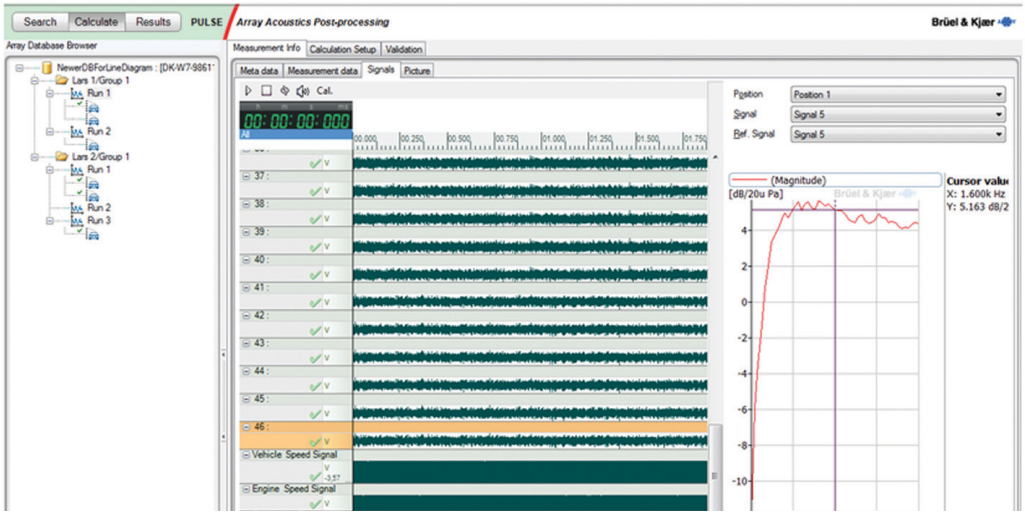
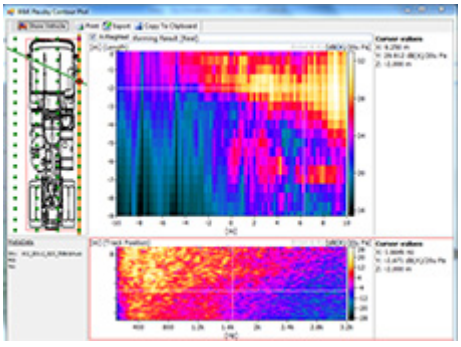
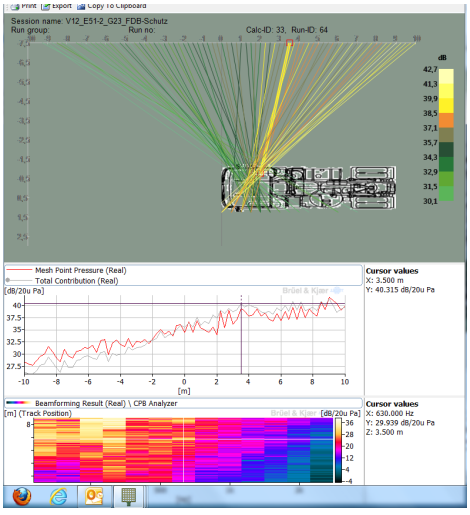


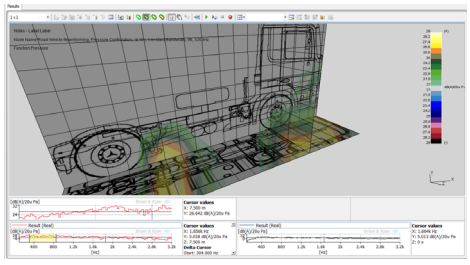
Fig. 3 *Measurement Information in Array Acoustics Post-processing showing the measured time signals: acoustical signals, vehicle speed, engine speed, etc.*

Results

Fig. 4 *Examples of result displays.* ***Left****: Contour plot showing sound pressure level as a function of vehicle position on track.* ***Centre****: Line diagram showing maximum sound pressure levels as a function of vehicle position on track.* ***Right****: Multiple planes showing 3D mapping of data. This representation is only relevant for vehicles with open structures such as lorries.*







BZ-5943 is an option for Array Acoustics Beamforming Type 8608, a Windows®-based Noise Source Identification (NSI) application for PULSE LabShop

Software is delivered via installation media (DVD or USB). The licence is either: node-locked to a PC host ID or dongle; or floating, locked to a network server

SYSTEM REQUIREMENTS

- The following BK Connect applications:
  - Data Viewer Type 8400
  - Hardware Setup Type 8401
  - Hardware Setup (advanced) Type 8401-A
  - Data Processing Type 8403
  - Array Analysis Type 8430 (includes PULSE Acoustic Test Consultant Type 7761, see Product Data BP 1908)
- PULSE (NSI) Array Acoustics Beamforming Type 8608
- Microsoft® Windows® 10 Pro or Enterprise (x64) with either Current Branch (CB) or Current Branch for Business (CBB) servicing model; or Windows® 7 Pro, Enterprise or Ultimate (SP1) (x64) operating systems
- Microsoft® Office 2016 (x32 or x64) or Office 2013 (x32 or x64)
- Microsoft® SQL Server® 2014 Express (SP2) (included in installation), SQL Server® 2014 (SP2), SQL Server® 2012 R2, SQL Server® 2008 or 2008 R2 Express Edition SP1

RECOMMENDED SYSTEM CONFIGURATION

- Intel® Core™ i7, 3 GHz processor or better
- 32 GB RAM
- 480 GB Solid State Drive (SSD) with 20 GB free space, or better
- 1 Gbit Ethernet network*
- Microsoft® Windows® 10 Pro or Enterprise (x64), CB
- Microsoft® Office 2016 (x32)
- Microsoft® SQL Server® 2014 (SP2)
- Screen resolution of 1920 × 1080 pixels (full HD)

* A dedicated data acquisition network (LAN or WAN) is recommended; a network that only handles data from the front end improves the stability of the data

Ordering Information

Systems using BZ-5943, including PULSE Vehicle Pass-by Test Systems (see Product Data BP 2496) for testing pass-by noise of accelerating road vehicles according to ISO 362, are ordered through Project Sales.

Licences are either node-locked or floating

BZ-5943	**PULSE Array Acoustics, Road Vehicles Moving Source Beamforming**

SOFTWARE MAINTENANCE AND SUPPORT AGREEMENT

M1-5943	Agreement for BZ-5943

BP 2453 – 12 2018-02

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