PRODUCT DATA

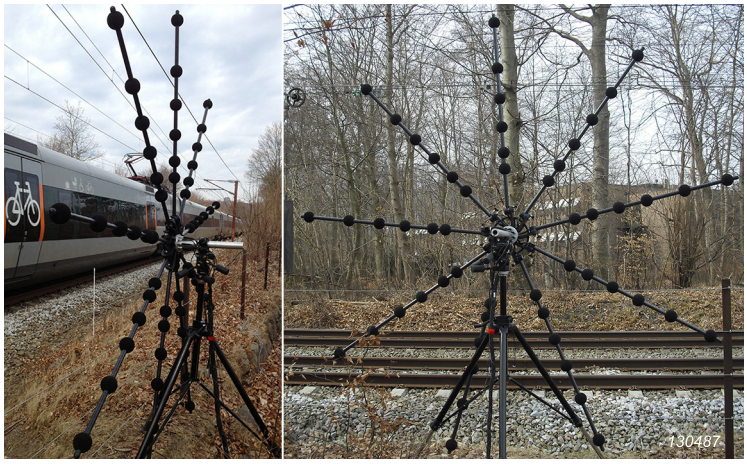
PULSE Array Acoustics, Rail Vehicles Moving Source Beamforming BZ-5939

PULSE™ LabShop > PULSE Array Acoustics, Beamforming Type 8608 > Option BZ-5939

Rail Vehicles Moving Source Beamforming BZ-5939 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-5939 follows linear movement parallel to the planar microphone array and enables speed-position calculation from a pulsed speed signal, or photocells. The option also enables a display of mapping versus position and pressure contribution versus position and frequency at the same time. The display of the results has been optimized to accommodate long rail vehicles.



Uses and Features

Uses

- Troubleshooting contribution during pass-by measurements
- Locating noise sources radiating from moving rail vehicles, for example, trams or trains
- Mapping planes from the side 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.

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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-5939 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 railway track. 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.

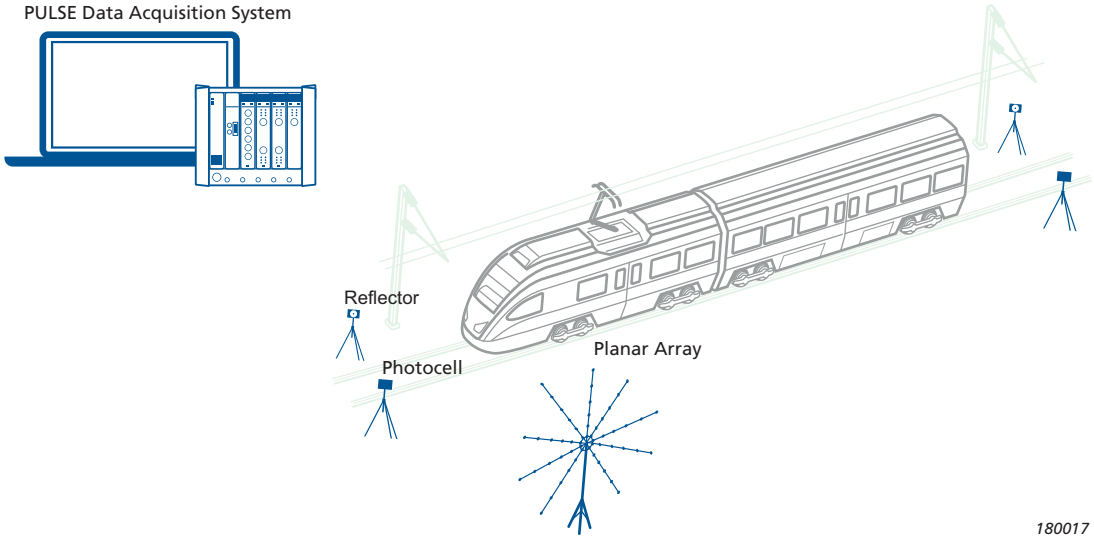

Fig. 1
Typical setup for Rail Vehicles Moving Source Beamforming BZ-5939

Positioning

Rail 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.

BZ-5939 assumes a constant velocity: a fixed speed (known or unknown) and a fixed direction. The position of the rail vehicle is determined using photocells, which can also be used to determine the speed if it is unknown:

- If speed is known, use a single photocell to trigger position and manually enter speed
- If speed is unknown, use two photocells to trigger position and calculate speed

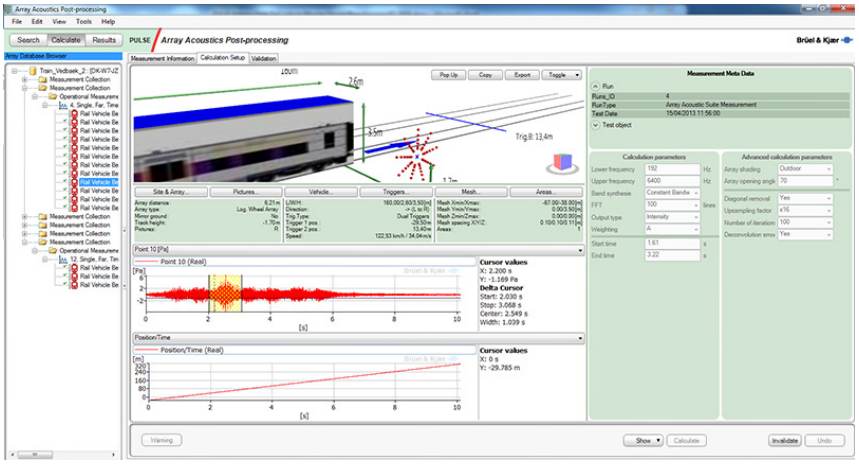

Fig. 2
Calculation Setup in Array Acoustics Post-processing showing position of vehicle on test track and the position of the array to be used when displaying the results

Processing

BZ–5939 utilizes 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.

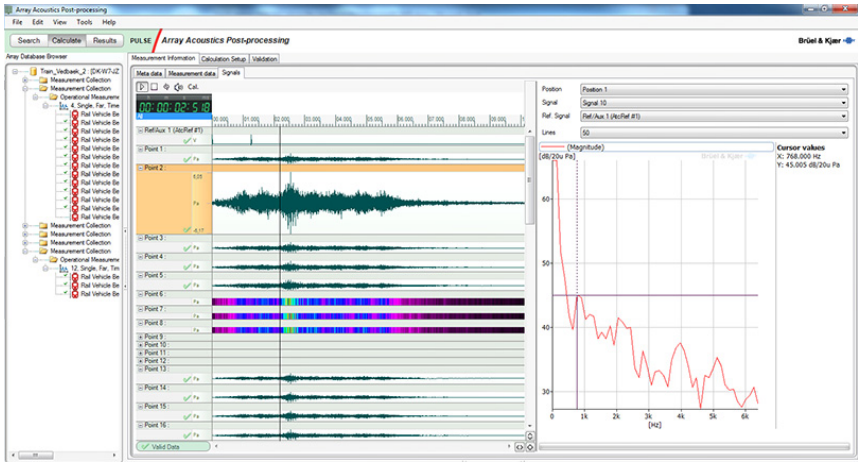

Fig. 3
In Measurement Information within Array Acoustics Post-processing, you can view the time signals and cross-spectra between reference and array microphones at selected positions

Results

Acoustical maps of pressure, pressure contribution density and sound intensity can be calculated and displayed for the whole or part of the rail vehicle. Smaller areas covering the pantograph or wheels sets can be defined and the contributed sound power can be calculated thus enabling the user to easily rank the areas in order of importance.

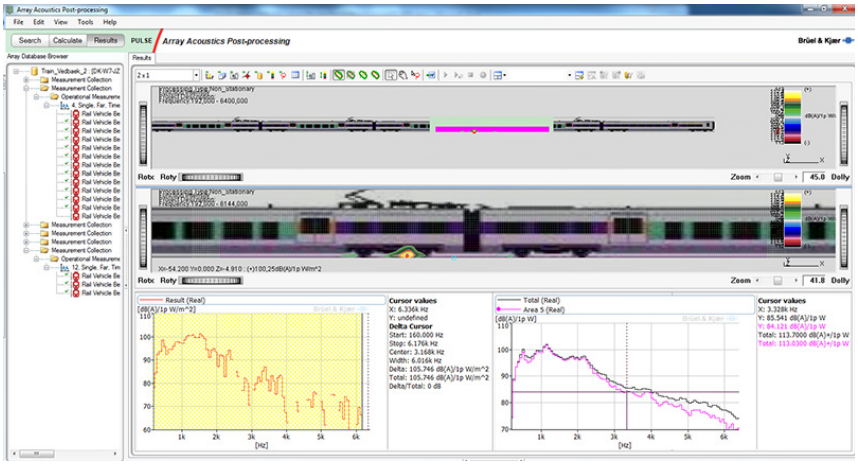

Fig. 4
Mapping of sound intensity (upper plot) and pressure contribution (lower plot). The total sound power and the contribution from the bogies are shown in the lower left graph

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. Brüel & Kjær patented arrays suppress ghost images by numerically optimizing the microphone positions to give a high side-lobe attenuation over a wide frequency range.

Rail Vehicles Moving Source Beamforming supports a variety of arrays: 30-channel pentangular arrays, 42-channel half-wheel arrays, and 144-channel wheel arrays can all be used.

***Fig. 1 Left**: 30-channel pentangular array; **Centre**: 144-channel wheel array; **Right**: Example of an acoustic array used in measuring high-speed trains (photo courtesy of TPL, China)*

Specifications – PULSE Array Acoustics, Rail Vehicles Moving Source Beamforming BZ-5939

BZ-5939 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 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

Due to the number and variety of components, systems are ordered through Project Sales.

Licences are either node-locked or floating.

BZ-5939	**PULSE Array Acoustics, Rail Vehicles Moving Source Beamforming**

SOFTWARE MAINTENANCE AND SUPPORT AGREEMENT

M1-5939	Agreement for BZ-5939

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