

## PULSE Array Acoustics, Flyover Moving Source Beamforming BZ-5940

PULSE™ LabShop > PULSE Array Acoustics, Beamforming Type 8608 > Option BZ-5940

*Flyover Moving Source Beamforming BZ-5940 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-5940 provides a high-resolution acoustic map of sound sources using one simple measurement of an aeroplane as it flies over a ground-based array of microphones by differentiating sound levels based on the direction from which they originate.*



### Uses and Features

#### Uses

- Research and development NSI flyover tests
- Certification NSI flyover tests
- NSI tests on undercarriage, slats and flaps, and engines of subsonic transport aircraft
- Flyover tests at altitudes between 30 and 300 m

#### Features

- Record time, position and sound signals during measurements
- Transient-tracked analysis using flight track information via Global Positioning System (GPS) time stamps
- Diagonal removal (to suppress noise contributions from wind)
- Deconvolution algorithms improve spatial resolution
- Post-processing of data

### Noise Source Identification Using BZ-5940

Flyover Moving Source Beamforming BZ-5940 is an option for PULSE Array Acoustics Beamforming Type 8608 for array-based NSI (see Product Data [BP 2144](#) for more information).

BZ-5940 uses a standard tracking time-domain delay and sum (DAS) algorithm to perform beamforming calculations. Spectral noise source maps are created using fast Fourier transformation (FFT) and averaging in short time intervals.

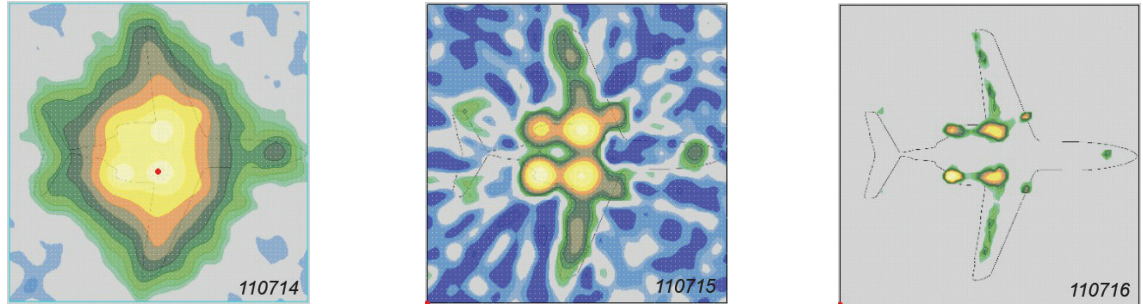
To provide a high-resolution acoustic map, array shading and deconvolution are used, see Fig. 1. An FFT-non-negative least squares (NNLS) algorithm for deconvolution is used to enhance resolution, suppress sidelobes and scale the maps.

See [Technical Review, No. 1 2012: High-resolution Fly-over Beamforming](#) for further information about flyover NSI methods.

In a joint research project between Japan Aerospace Exploration Agency (JAXA) and Brüel & Kjær, measurement data for the full bandwidth of a complete flyover was recorded. Fig. 1 shows the results produced using BZ-5940 for the 2 kHz octave band with the nose of the aircraft exactly over the array centre ( $x = 0$ ) under the following conditions: landing configuration, level flight, engine idle, altitude 59 m, and speed 57 m/s.

**Fig. 1**  
Improvement of resolution by means of shading and deconvolution

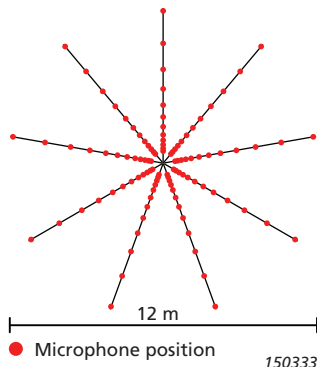
**Left:** DAS  
**Centre:** DAS + shading  
**Right:** DAS + shading + deconvolution



Array-based Noise Source Identification

Flyover Moving Source Beamforming BZ-5940 is an array-based NSI solution and, therefore, relies on an array-based measurement method.

**Fig. 2**  
Microphone spacing of WA-1652-W-002



For flyover tests, Horizontal Wheel Array WA-1652-W-002 is designed for quick, precise set up. The arms of the array join to a central plate and are spaced quickly and easily with aluminium arcs. Each arm is an identical line array made of an aluminium tube with microphones that click into place.

WA-1652-W-002 has a diameter of 12 m and 9 arms. Each arm contains 12 microphones for a total of 108 channels. It accurately measures from 600 Hz to 6 kHz. For improved low-frequency resolution (300 Hz to 6 kHz), you can easily upgrade the array. A set of 9 extension arms for the array increases the diameter to 30 m and adds 3 microphones to each arm for a total of 135 channels.

The microphone spacing of the wheel array is such that the central region has a higher concentration of microphones, see Fig. 2. At high frequencies, only the central part of the array with small microphone spacing is used. At low to medium frequencies, an additional weighting factor is applied to the microphones to counteract the resolution loss from the high microphone density at the centre.

## Typical System

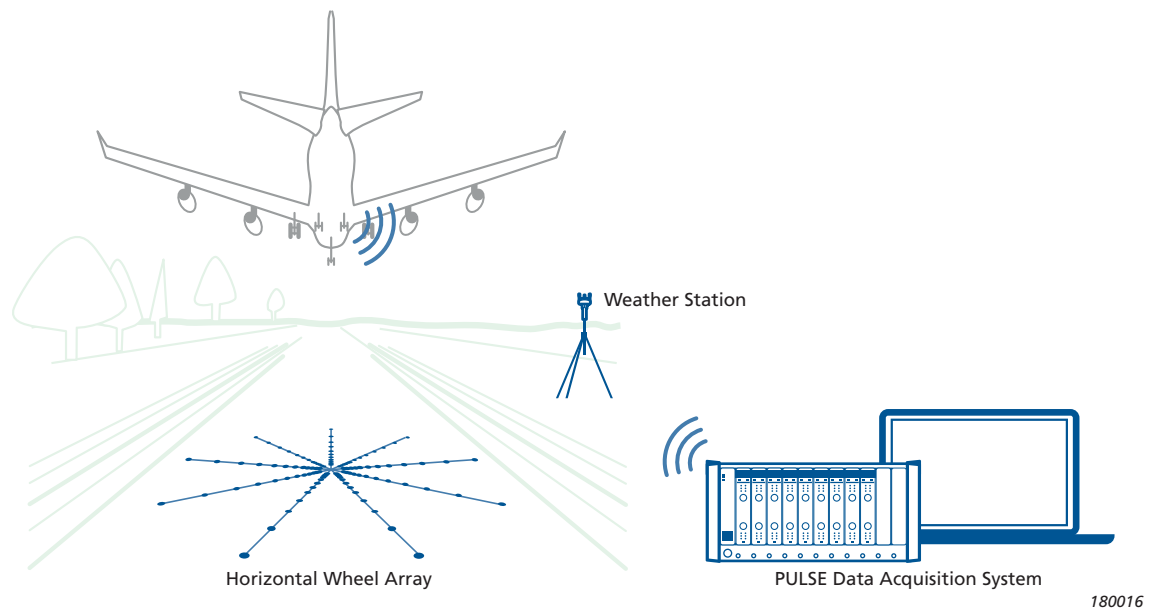
During an NSI flyover test, the ground-based array of microphones measures the passing aircraft. Microphone measurements are collected and time-stamped by the LAN-XI Front End with GPS. The position, speed, roll, yaw and pitch of the aircraft is recorded and time-stamped with on-board GPS. All data is synchronized, and the PULSE software performs beamforming, array shading and deconvolution calculations to create a high-resolution acoustic map.

A typical system for PULSE Array Acoustics, Flyover Moving Source Beamforming BZ-5940 includes the following:

- Horizontal Wheel Array
- LAN-XI Data Acquisition Hardware
- PULSE Array Acoustics Beamforming Type 8608, including BZ-5940

All systems using BZ-5940 are ordered via Project Sales.

**Fig. 3**  
Typical flyover NSI  
system featuring  
BZ-5940



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## Optional Weather Station

Your flyover NSI system can be configured to include environmental conditions. Temperature, relative humidity, barometric pressure, wind speed and direction, and precipitation can be recorded with a weather station. Discuss this option with the Project Sales Office when designing your system.

# Specifications – PULSE Array Acoustics, Flyover Moving Source Beamforming BZ-5940

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-5940**                      **PULSE Array Acoustics, Flyover Moving Source Beamforming**

## SOFTWARE MAINTENANCE AND SUPPORT AGREEMENT

M1-5940                      Agreement for BZ-5940

## Typical System

### HORIZONTAL WHEEL ARRAY

1 × WA-1652-W-002    108-channel Horizontal Wheel Array (diam. 12 m, 9 arms)  
108 × Type 4958        20 kHz Precision Array Microphone  
18 × WL-1297-x-yyy†    Microphone Cable, circular 1B 7-pin (M) to circular 1B 7-pin (M), +70 °C (158 °F)

**Option:** Upgrade WA-1652-W-002 to a 135-channel horizontal wheel array with a set of 9 extension arms

## PULSE DATA ACQUISITION SYSTEM

### Measurement and Analysis Software

Type 8400                      BK Connect Data Viewer  
Type 8401                      BK Connect Hardware Setup  
Type 8401-A                    BK Connect Hardware Setup (advanced)  
Type 8403                      BK Connect Data Processing  
Type 8430                      BK Connect Array Analysis  
Type 8608                      PULSE Array Acoustics, Beamforming  
BZ-5940                      Flyover Moving Source Beamforming, option for Type 8608  
BZ-5639                      Refined Beamforming, option for Type 8608

† x = D (decimetres) or M (metres)  
yyy = length in decimetres or metres  
Please specify cable length when ordering

## Software Maintenance and Support Agreements

M1-8400                      Agreement for 8400  
M1-8401                      Agreement for 8401  
M1-8401-A                    Agreement for 8401-A  
M1-8403                      Agreement for 8403  
M1-8430                      Agreement for 8430  
M1-8608                      Agreement for 8608  
M1-5940                      Agreement for BZ-5940  
M1-5639                      Agreement for BZ-5639

Software Maintenance and Support Agreements are available for all software packages.

## LAN-XI Data Acquisition Hardware

1 × Type 3660-D-100    11-module LAN-XI Front-end Frame with GPS  
9 × Type 3053-B-120    12-channel Input Module LAN-XI 25.6 kHz (CCLD, V)  
9 × UA-2112-120        LAN-XI Front panel, detachable, 12 channels for array microphones, 2 × circular 7-pin (F) connectors

## Optional Weather Station

A weather station requires the following:

- MM-0256: 6-parameter Weather Station Kit, uses Vaisala Weather Transmitter WXT520
- WT-9876: Weather Station GADI Driver
- M1-9876: Maintenance and Support Agreement for WT-9876

## ACCESSORY

UA-0801                      Lightweight Tripod for Weather Station

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