PRODUCT DATA

PULSE Array Acoustics, Wind Turbines Moving Source Beamforming BZ-5941

PULSE™ LabShop > PULSE Array Acoustics, Beamforming Type 8608 > Option BZ-5941

Wind Turbines Moving Source Beamforming BZ-5941 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.

Measurements using BZ-5941 are performed with a large ground-based array of microphones. The application visualizes the results as a contour plot showing the noise contribution on the surface of interest.

Uses and Features

Uses

- Troubleshooting noise measurements on operating wind turbines
- Locating noise sources radiating from operating wind turbines
- Analysing component pressure contribution
- Mapping sound intensity
- Determining sound power

Features

- Wind turbine geometry defines mapping surface
- Model of wind profile can be defined to improve accuracy
- Deconvolution analysis – greater spatial resolution than delay and sum beamforming
- Ground-based microphone array
  - Outward looking – maps targets much larger than itself
  - Modular design for easy transport and deployment
- Noise mapping with blade tracking: azimuth reference signal used to track individual blades as a function of angle and frequency
- Noise mapping without blade tracking: rapid overview of sound radiation
- Automatic Doppler correction
- Linear and A-weighted sound maps
- AVI file format for presentations and reports

Brüel & Kjær

Beamforming

The sound field radiating from a test object is measured using an elliptical, planar array of microphones placed on the ground at some distance from the object. 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.

When using a ground-based array, a totally reflective ground plane is assumed.

Wind Turbines Moving Source Beamforming

By using a tracking beamforming approach, measurements can be made on an operating wind turbine. Knowing the position of the turbine and measuring the blade(s) azimuth angle, focus points can follow the movement of the blades, and the noise map can be visualized on the blade(s) for each azimuth angle step.

Typical System

The hardware typically used consists of a data acquisition system (measurement and analysis software plus data acquisition hardware) and a planar array and one or more reference signals for measuring the azimuth angles of the wind turbine blades. Weather stations are supported, but optional.

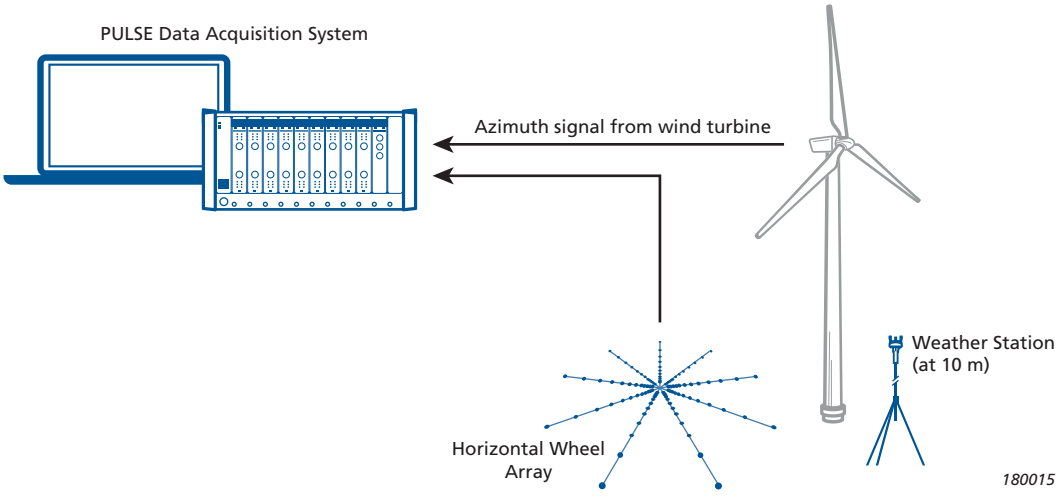


Fig. 1
Typical setup for Wind Turbines Moving Source Beamforming

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. 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.

Fig. 2
Typical elliptical ground-based array with 108 microphones (dimensions 13.6 × 8.5 m) deployed on a tarpaulin ready for measurement

Processing

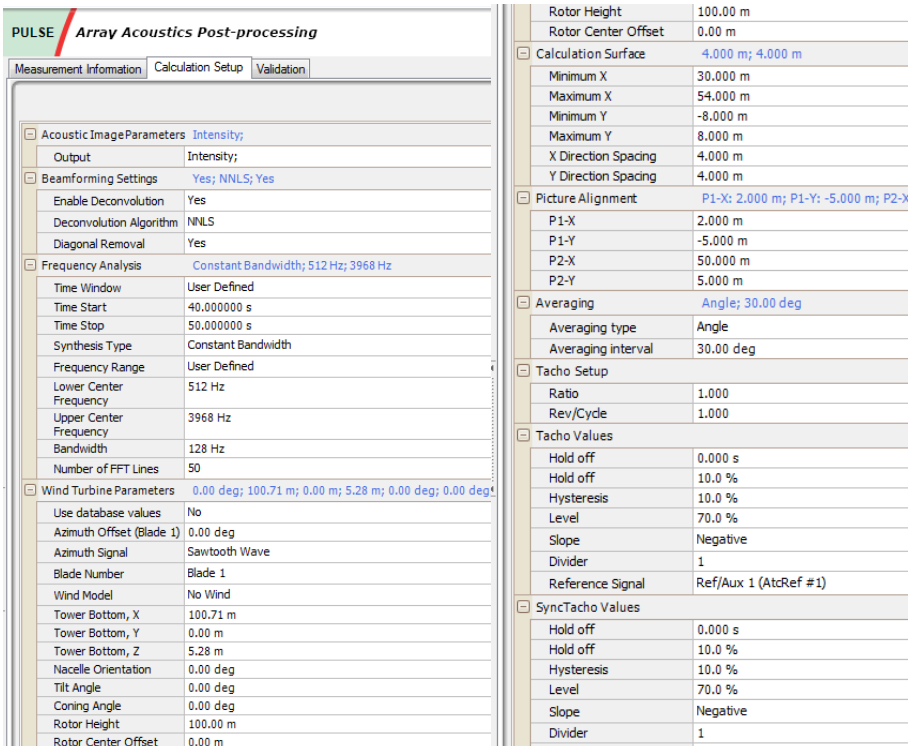
BZ-5941 utilizes up-sampling rather than unnecessarily devouring massive amounts of data storage space. For example, measurements recorded with 8192 samples/s are up-sampled by a factor of 16. This method

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.

Calculation Setup

Post-processing is performed using PULSE Beamforming Type 8608 in the Array Acoustics Post-processing application. Dimensions and photographs of the turbine are entered in the Calculation Setup. The acoustical signals and the azimuth signal can be checked before performing the calculations.

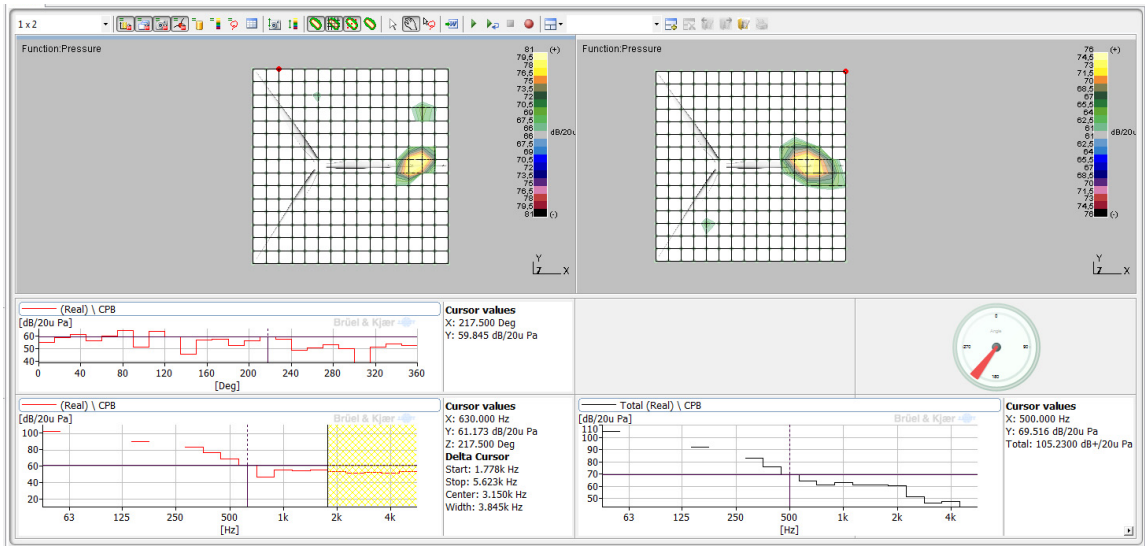
Fig. 3
Calculation Setup in Array Acoustics Post-processing



Calculations and Results

Deconvolution can be applied to the delay and sum beamforming to improve the spatial resolution in order to distinguish between noise events on the leading and the trailing edge of the blade. The type of wind profile model (none, linear or user-defined) is also set here. The end result of the dominant noise sources is shown as a contour plot overlaid on a picture of the rotor/blade.

Fig. 4
Results of blade tracking measurements on a wind turbine



Specifications – PULSE Array Acoustics, Wind Turbines Moving Source Beamforming BZ-5941

BZ-5941 is an option for PULSE 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 variety of possible configurations, systems that include BZ-8941 are ordered via Project Sales.

Licences are either node-locked or floating

BZ-5941	**PULSE Array Acoustics, Wind Turbines Moving Source Beamforming**

SOFTWARE MAINTENANCE AND SUPPORT AGREEMENT

M1-5941	Agreement for BZ-5941

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