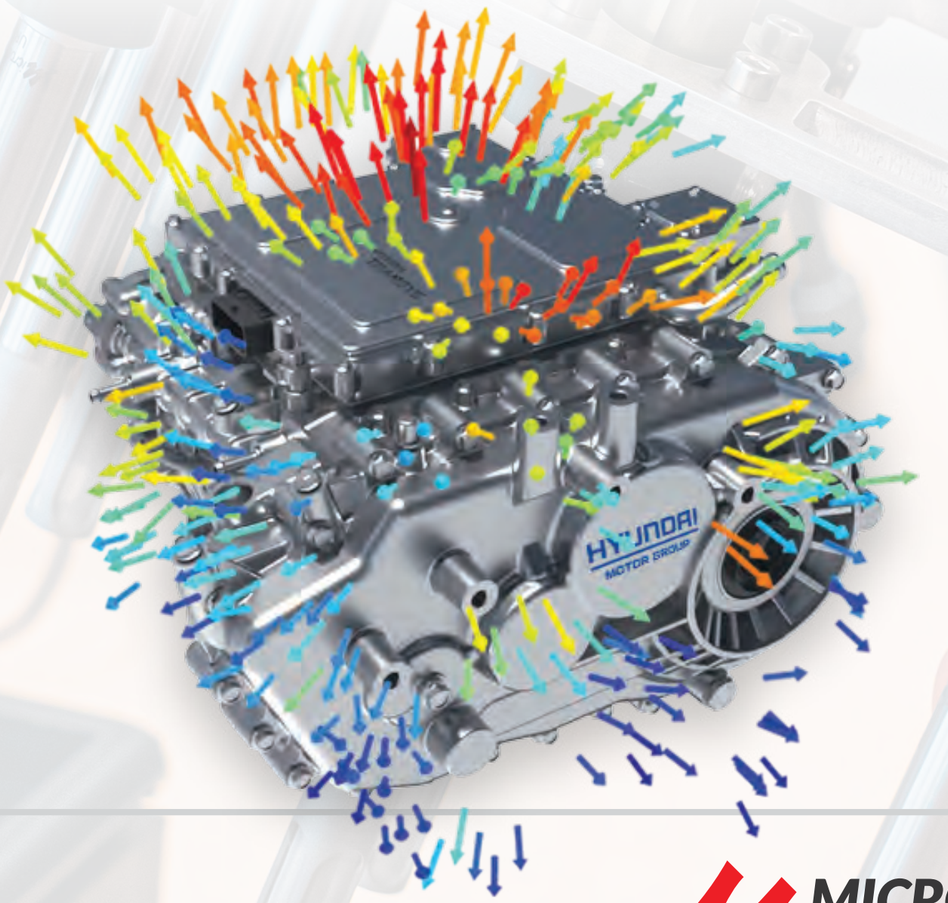
ACOUSTIC SHAPE

3D VISUALIZATION OF TRANSIENT AND NON-STATIONARY SOUND FIELDS



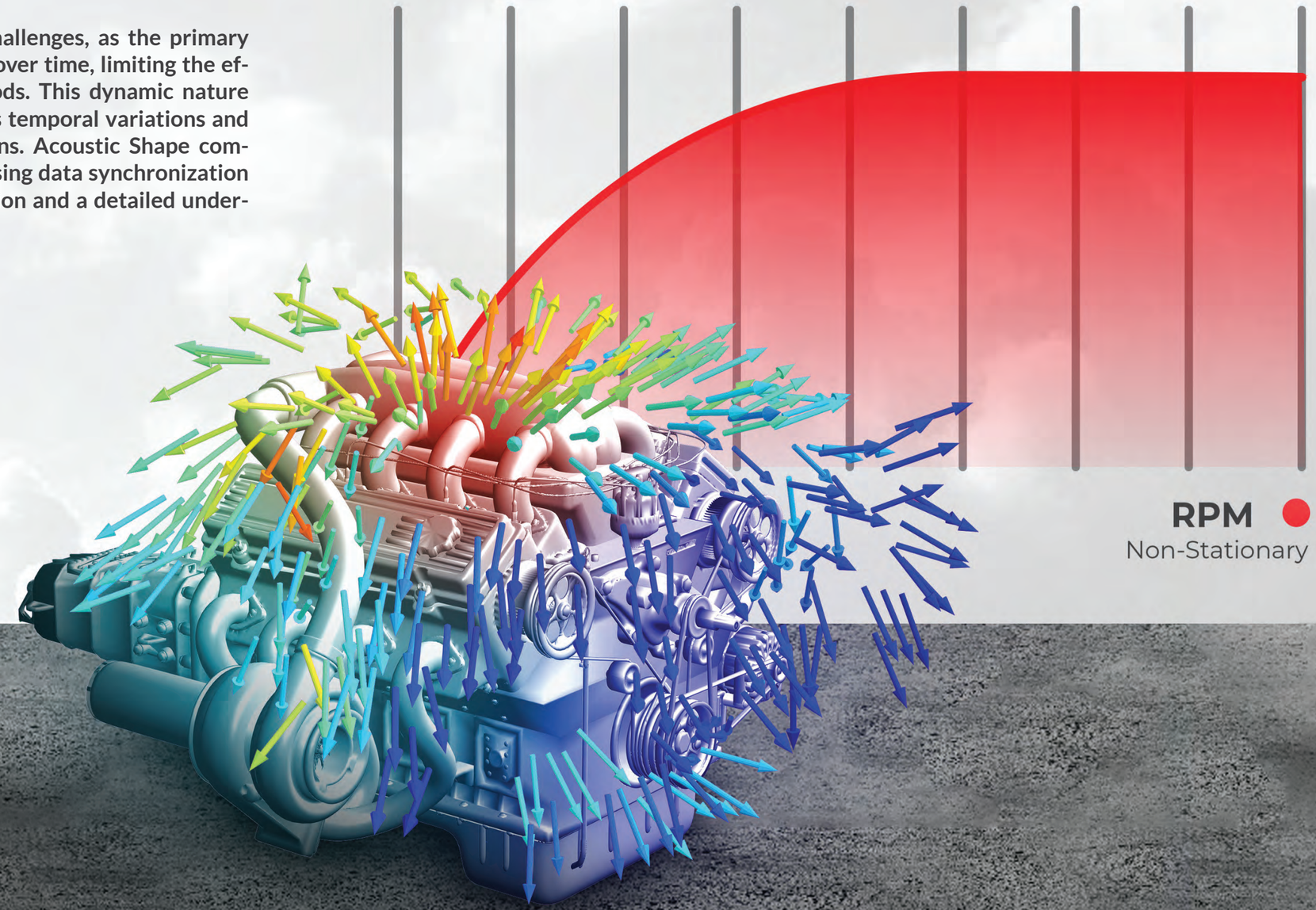
MICROFLOWN TECHNOLOGIES

Product leaflet

Acoustic Shape

CHALLENGES IN UNDERSTANDING TRANSIENT SOUNDS

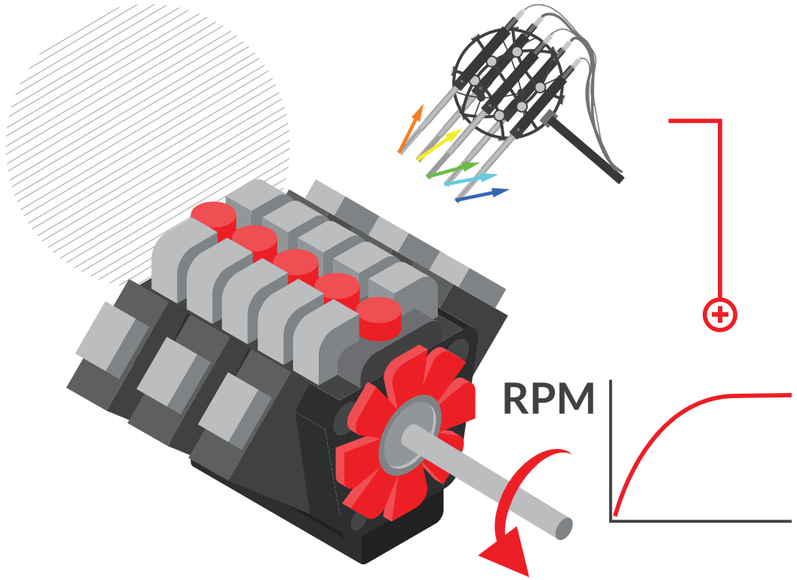
Localizing non-stationary issues presents unique challenges, as the primary noise sources change in both position and intensity over time, limiting the effectiveness of traditional stationary analysis methods. This dynamic nature requires reference sensors that adapt to the sound's temporal variations and track changes under different operational conditions. Acoustic Shape combines advanced analysis algorithms and post-processing data synchronization to meet these demands, ensuring precise identification and a detailed understanding of evolving sound fields.



Synchronizing Complex Data

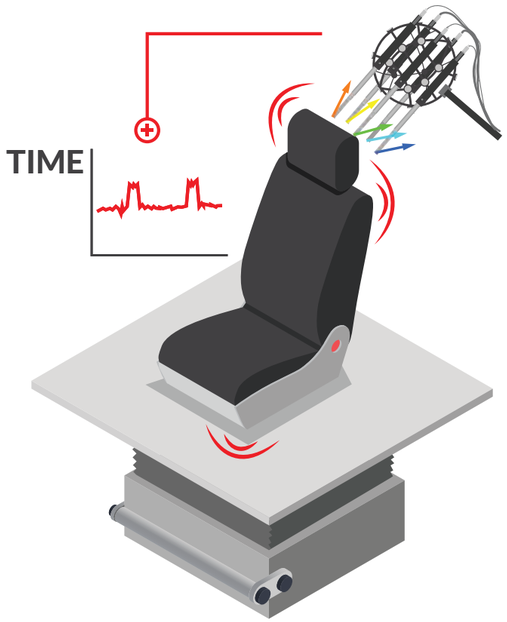
ACOUSTIC DATA ANALYSIS

Transform raw acoustic data into actionable insights, revolutionizing how you understand and optimize machinery performance. Unlock the full potential of your data and stay ahead of the curve with our cutting-edge features for acoustic analysis.



Order & spectral analysis over RPM

Our system includes an order analysis module for assessing the vibro-acoustic output of rotational components, with or without a tacho sensor. The Order Tracking Module characterizes rotating machinery by analyzing signal frequency relative to a reference rotation speed. It can extract rotational orders without an RPM signal by using a highlighted order in the spectrogram as a reference. An algorithm then calculates an effective RPM reference for determining order spectrum, resulting in dynamic 3D sound visualizations. With a reference tacho or RPM signal, users can calculate sound pressure, 3D particle velocity, and 3D sound intensity for various operational conditions. This method is effective for localizing issues like structural modes or cavity resonances independent of rotational speed.

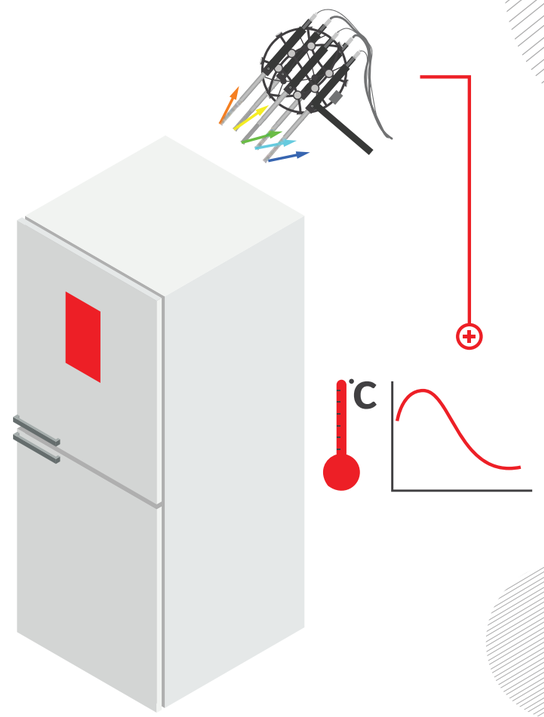


Spectral analysis over time

This post-processing method allows you to perform a detailed analysis of a single capture to investigate how the radiated sound pressure, particle velocity, or sound intensity field changes over time. A reference signal is not required for this type of analysis. Data from multiple captures can be combined by selecting multiple time intervals of interest and sticking together the vibro-acoustic data captured at different locations.

Spectral analysis over non-rotational references

Machinery that can be operated with repeatable cycles independent of a rotational excitation (e.g. temperature variations, torque or acceleration) can also be used in combination with Acoustic Shape. This processing method supports the usage of a non-rotational reference signal to synchronize multiple captures and calculate the resulting 3D acoustic radiation visualizations in terms of sound pressure, particle velocity, or sound intensity. This approach is very useful to study how noise is radiated with respect to the chosen reference stimuli, such as temperature variations of a product, changes in position, or loading forces.



Transient Noises and Non-Stationary Measurements

ACOUSTIC SHAPE AT A GLANCE

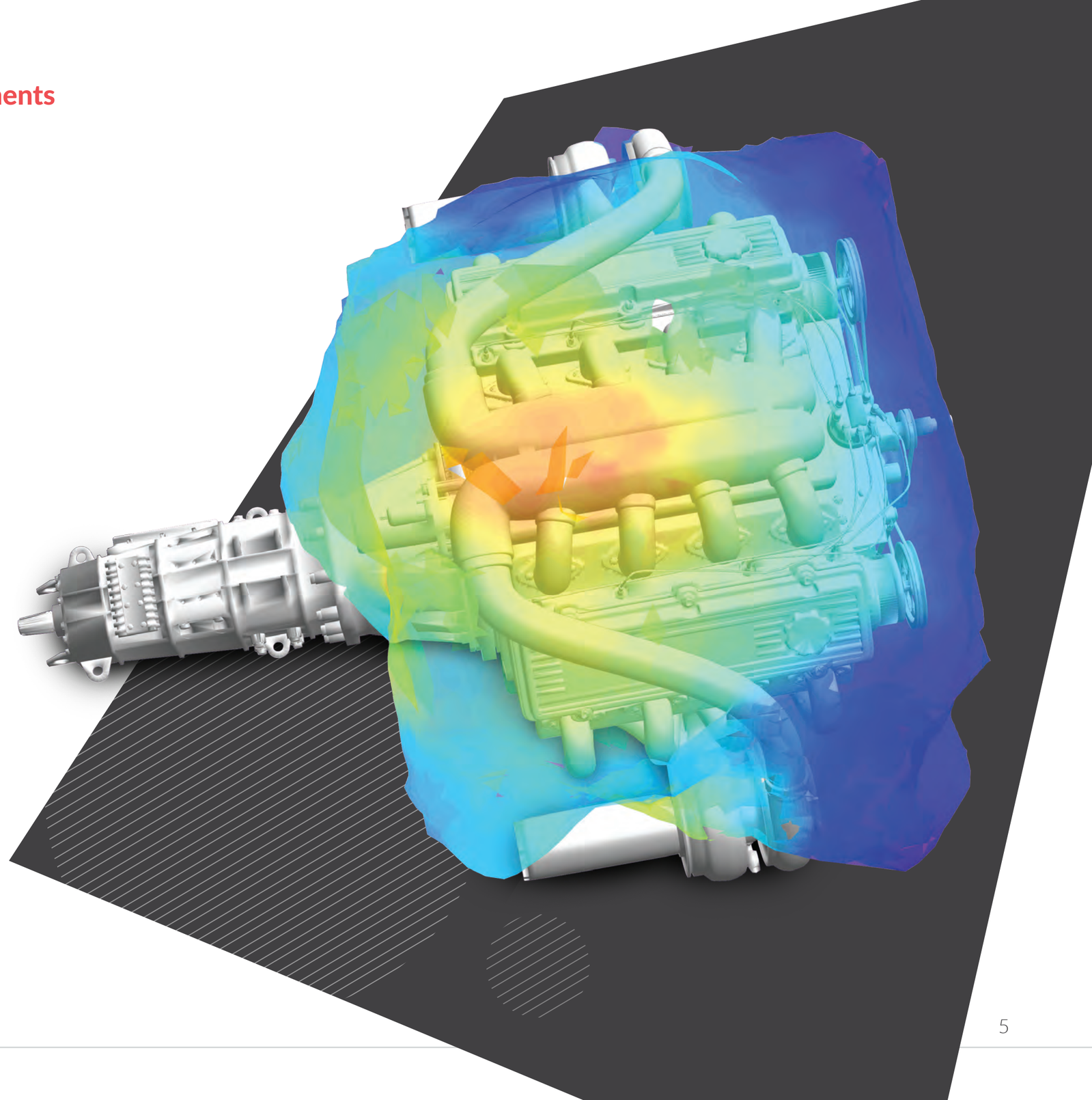
Sound source localization is an important topic in the working field of sound & vibration, from the product development stage to the end of line quality control.

Applications

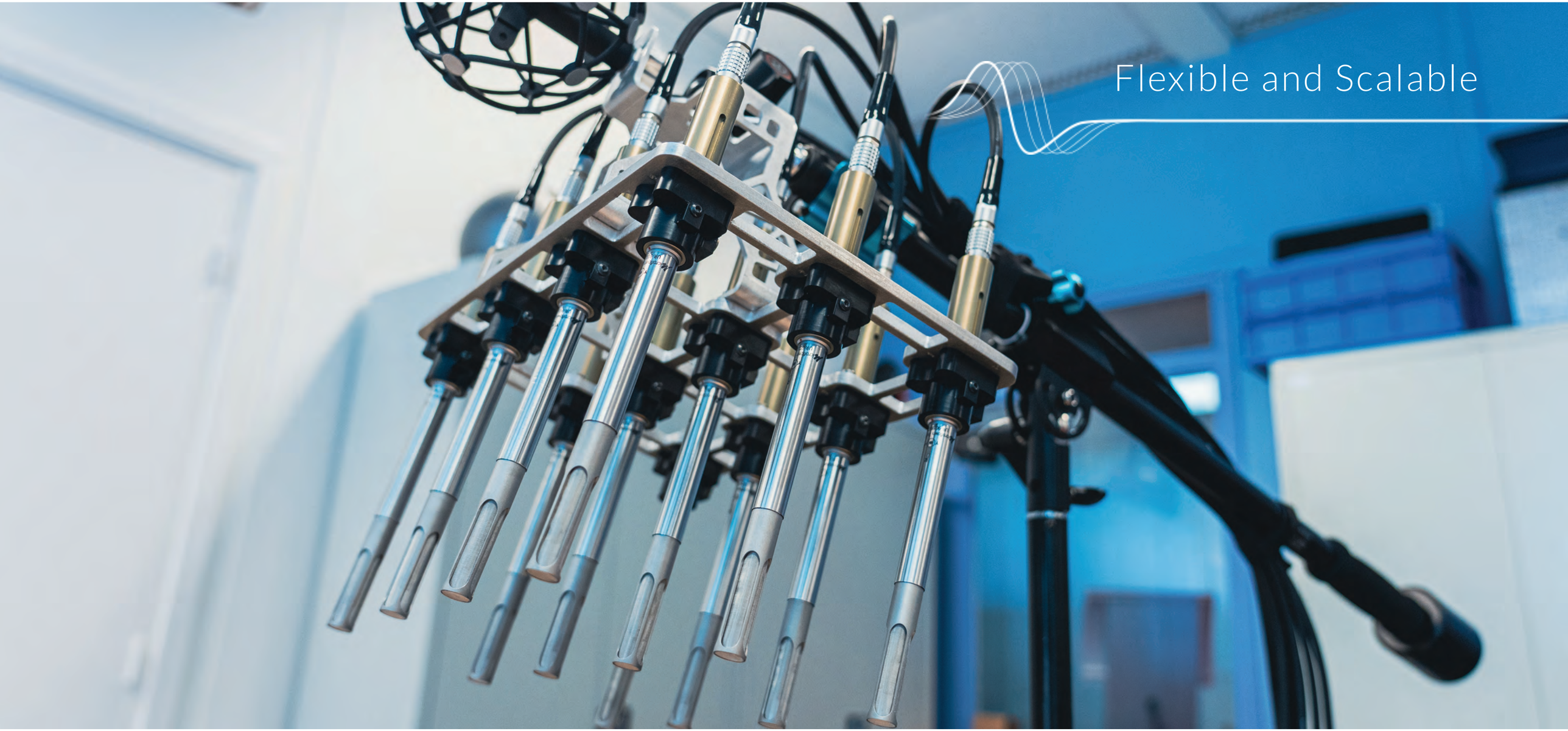
- Sound source localization
- 3D sound visualization
- Noise ranking
- Sound power quantification
- Sound pressure prediction
- Experimental data acquisition for numerical simulations
- Multi-sensor vibro-acoustic troubleshooting

Key features

- Broadband Solution | 20Hz - 10kHz
- Unmatched spatial representation
- Multi-capture synchronization using reference signals
- Automatic 3D tracking of the array position
- Order Tracking and order analysis tools
- Flexible array configurations
- Sound pressure, 3D particle velocity and 3D sound intensity



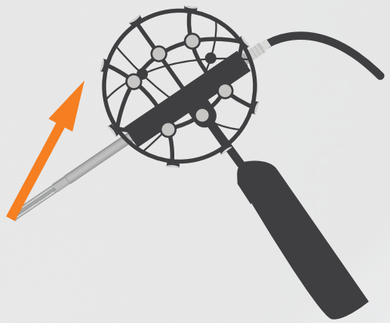
Flexible and Scalable

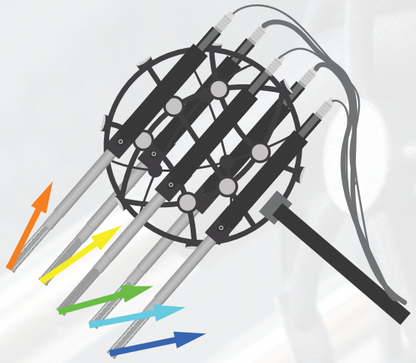


Customizable Acoustic Vector Sensor Arrays

EXPLORING CUSTOM HARDWARE POSSIBILITIES

Acoustic Shape is a flexible solution due to its versatile array configurations. It accommodates from single probe setup to more advanced arrangements including 5 or even 12 acoustic vector sensor probes, meeting a wide range of customer requirements.





SINGLE PROBE SETUP

The Single Probe Setup offers a straightforward approach to non-stationary noise localization. Its hardware configuration is similar to the Scan&Paint 3D, providing users with a familiar, user-friendly platform. This setup is particularly suited for those who have a basic understanding of acoustic measurements and seek a cost-effective entry point. The primary benefit lies in its simplicity and the unique opportunities it presents for quick assessments and preliminary diagnostics in various environments. It represents an accessible option for users to start with acoustic characterization without the need for complex configurations.

5 PROBE ARRAY

The 5 Probe Array offers a step up in detail and precision from the single probe setup. Fixed in its configuration, this array does not offer the flexibility of probe movement but provides enhanced data acquisition over the single probe by employing five acoustic vector sensor probes. This setup is tailored for projects that require more detailed acoustic information than a single probe can offer, but where the ultimate flexibility and complexity of a larger array are not necessary. It strikes a balance between increased data collection capabilities and ease of use, making it an ideal choice for intermediate acoustic studies.

12 PROBE ARRAY

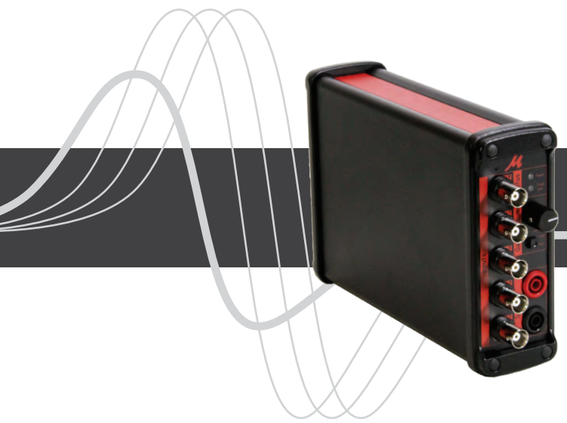
The 12 Probe Array is the most comprehensive solution for acoustic source characterization. It features twelve acoustic vector sensor probes in a large, adjustable array that allows for precise distance modifications between probes. This setup is designed for in-depth acoustic analysis, offering the highest resolution and accuracy. The variable probe positions enable detailed spatial analysis, making it possible to closely examine complex acoustic environments. Despite its complexity, the 12 Probe Array is invaluable for detailed studies, providing unmatched detail and efficiency in acoustic mapping.

Customizable and Scalable Data Acquisition Systems

EXPLORING CUSTOM HARDWARE POSSIBILITIES

Acoustic Shape is a flexible solution due to its versatile array configurations. It accommodates from single probe setup to more advanced arrangements including 5 or even 12 acoustic vector sensor probes, meeting a wide range of customer requirements.

SCOUT



The Scout V2 is a compact, portable data acquisition system designed for sound and vibration measurements. The system has 4 input channels, an extra dedicated tacho channel and an amplified output.

Reference Options

- ✓ **TACHO SENSOR** [RPM]
- AC-COUPLED SENSORS [ACCELERATION, PRESSURE, VOLTAGE]
- DC-COUPLED SENSORS [TEMPERATURE, ROTATION, DISPLACEMENT]

VOYAGER

The Voyager is a mobile acoustic analyzer combining data acquisition, signal conditioning, and storage in one unit. It has 6 input channels, 4 of them dedicated to Microflown sensors as well as 2 complementary AC-coupled inputs.

Reference Options

- TACHO SENSOR [RPM]
- ✓ **AC-COUPLED SENSORS** [ACCELERATION, PRESSURE, VOLTAGE]
- DC-COUPLED SENSORS [TEMPERATURE, ROTATION, DISPLACEMENT]

MECALC technologies

The MECALC//DECAQ is a multi-channel data acquisition platform, scalable up to 192 channels. Suitable for both field and lab setups, it ensures high-quality signal conditioning and is compatible with a range of sensors.

Reference Options

- ✓ **TACHO SENSOR** [RPM]
- ✓ **AC-COUPLED SENSORS** [ACCELERATION, PRESSURE, VOLTAGE]
- ✓ **DC-COUPLED SENSORS** [TEMPERATURE, ROTATION, DISPLACEMENT]

Enabling Acoustic Measurements Hazardous Areas

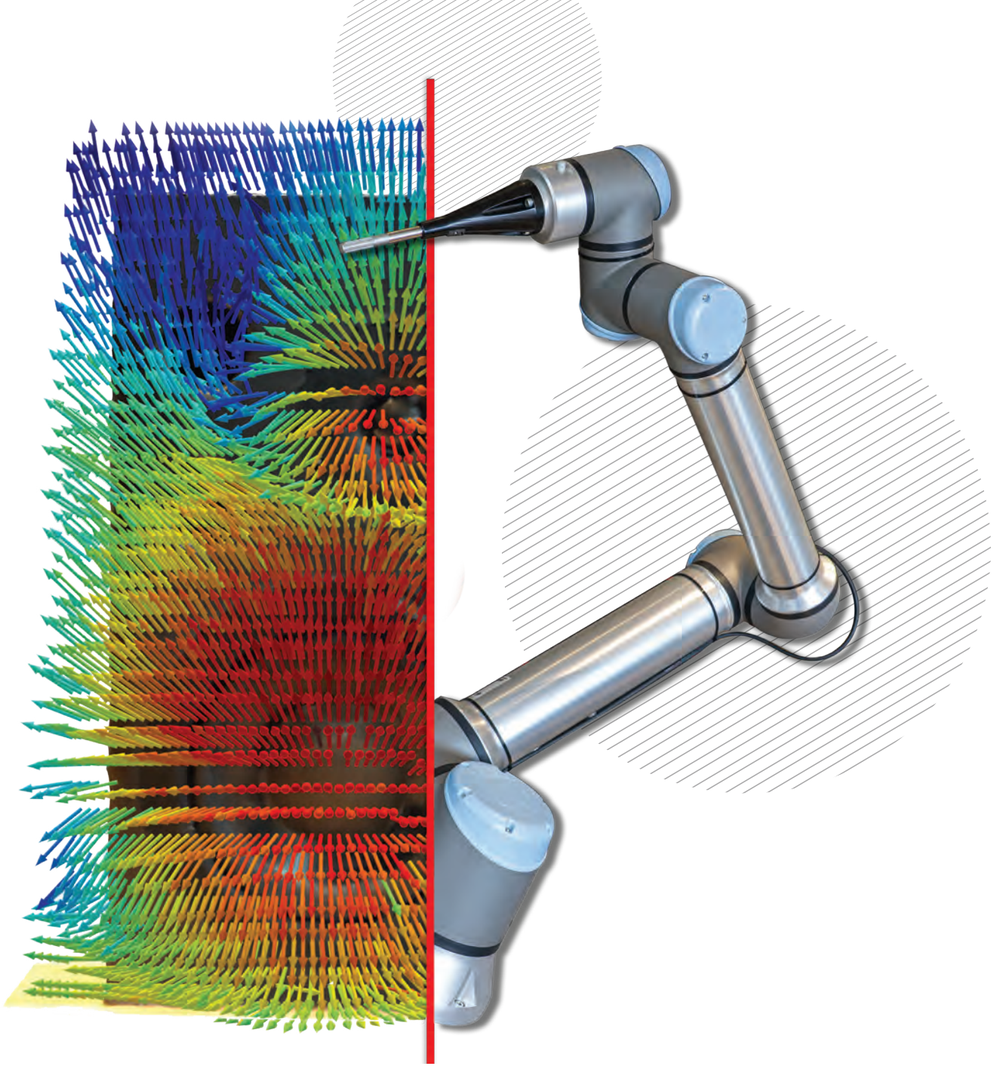
ROBOTIC ACOUSTIC SCANNER

Extending the versatility of acoustic shape, the Robotic Integration unlocks fully automated sound field visualization ideal wherever manual scanning is difficult, unsafe, or repetitive. By seamlessly combining the USP probe with collaborative robots such as the Universal Robot (UR), engineers gain a powerful tool for high-precision, repeatable measurements in virtually any environment.

A dedicated probe adapter ensures fixed positioning and orientation, while spacer tools maintain controlled probe distance, even on curved or complex surfaces. This guarantees consistent data, removes operator variability, and allows long test campaigns without human intervention.

Beyond safety and repeatability, robotic integration also enhances efficiency. Measurements that once demanded extended operator time can now be performed automatically, overnight, or in parallel with other tasks. With the robot executing precise scanning paths, engineers are free to focus on data interpretation, simulation, and design improvements.

Whether in confined interiors, hazardous environments, or routine prototype testing, Robotic Integration ensures safe, accurate, and fully automated acoustic scanning. It provides engineers with reliable datasets that strengthen benchmarking, accelerate product development cycles, and open new possibilities for measuring previously inaccessible areas.



Robotic Integration Highlights

- Automated & repeatable measurements
- Safe in confined or hazardous environments
- Extended reach into complex geometries
- Continuous or unmanned test campaign

List of included items

HARDWARE OPTIONS

Everything you need, in one rugged, ready-to-go case. The All-in-One Box Solution includes a full suite of professional-grade tools for advanced inspection and analysis.

Acoustic shape | 1 probe configuration
Voyager DAQ
- Lanyard
- Sony WH-1000XM4 Headphones
- Tripod Adapter (1/4 to 3/8)
- Firmware Reset Ejector Pin
USP Regular
- Metal Probe Case
- Calibration Report
PST Iris camera (BASE or HD)
CAMLINK tripod
Cables:
- 5 m LEMO 7pin male to male cable
- 3 m high-speed data USB-A to USB-C cable
- 2 m USB-A to Micro-B cable
Remote handle + Reciever
Tracking Sphere
Pelicase 1650 + inlay
Sentinel HL Max | USB dongle
32 GB USB stick (Calibration report/manuals/software)
Manfrotto PIXI Mini Tripod Black

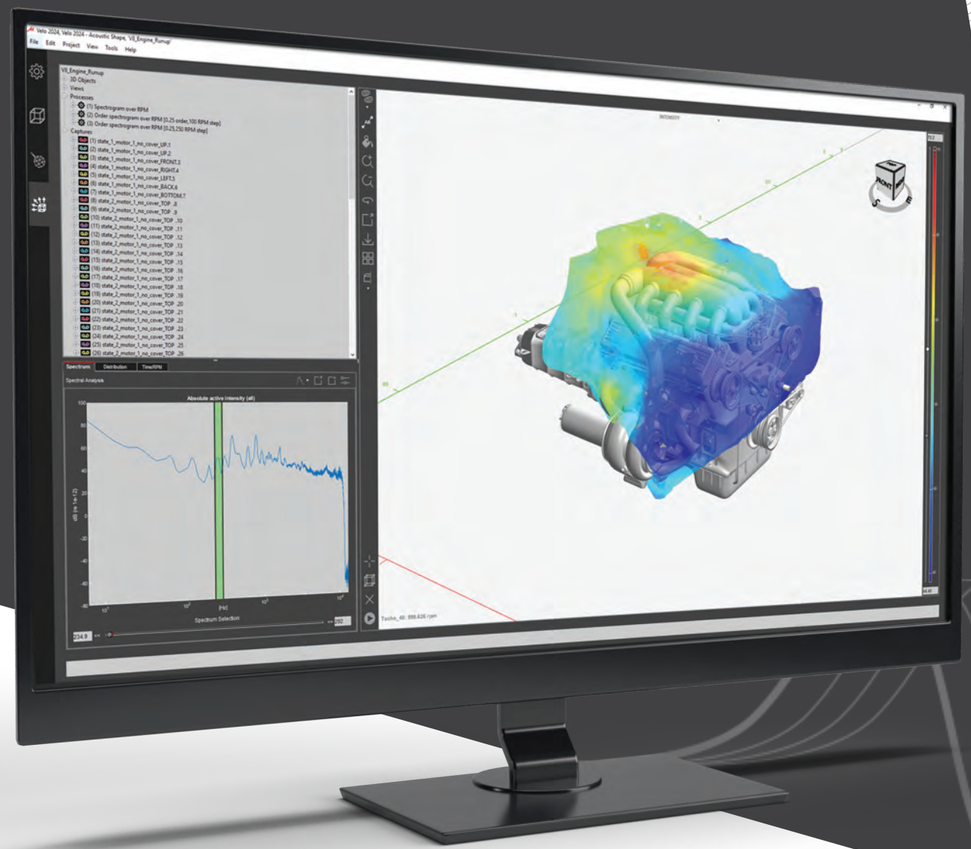
Acoustic shape | 5 probe configuration
MeCalc Frontend for 5 Probe Array | 20x Voltage input + 2x Tacho input | DecaQ-3, QS-BNDL-01, DQ-VB10, CS-TAC-J 1000
Rack-mounted MFPA module for 5 USP probes, traveling rack Front panel and shelf for MeCalc
5x USP Regular
- Metal Probe Case
- Calibration Report
5 probe spherical tracker
Manfrotto PIXI Mini Tripod Black
PST Iris camera (BASE or HD)
Manfrotto Tripod Black
Sentinel HL Max | USB dongle
32GB USB stick (Calibration report/manuals/software)
Extra 3D Sphere with pointer

Acoustic shape | 12 probe configuration
MeCalc Frontend for 12 Probe Array | 50x Voltage input + 2x Tacho input | DecaQ-4, 2 units of QS-BNDL-01, SC42S, MD-ICS42L, CS-TAC-J 1000
Rack-mounted MFPA module for 12 USP probes, traveling rack Front panel and shelf for MeCalc
12x USP Regular
- Metal Probe Case
- Calibration Report
12 USP configurable array
PST Iris camera (BASE or HD)
Manfrotto Tripod Black
Sentinel HL Max | USB dongle
32GB USB stick (Calibration report/manuals/software)
Extra 3D Sphere with pointer

VELO Software Platform

NEXT LEVEL SOUND VISUALISATION SOFTWARE

With the introduction of VELO, we take a step forward, redefining the possibilities for non-stationary sound measurement. Acoustic Shape, among other products, now benefits from the advanced capabilities of VELO, enabling users to explore the frontiers of sound visualization with unparalleled ease and precision.



Bridging innovation and intuition in 3D sound visualization

Acoustic Shape comes as part of Microflown successful VELO software suite. It is one of the latest VELO applications to be introduced to the 64bit platform.

Acoustic Shape draws significant inspiration from the sucessful Scan&Paint 3D, incorporating many of its valuable features, familiar layout, and workflow. Designed with the objective of seamlessly bridging the gap between intricate measurement techniques and the delivery of exceptional 3D visualizations, this software represents a significant advancement for the Velo platform. It introduces the capability to characterize non-stationary sound sources in real time, elevating the user experience and operational efficiency to new heights.

The simplicity of its design belies the software's comprehensive toolkit. Users are empowered to import various 3D file formats and undertake measurements across multiple 3D geometries. It facilitates the comparison of different analytical configurations within a single project by enabling the creation of diverse processes, each tailored to specific variables. Most impressively, the software offers extensive data visualization tools, establishing itself as an indispensable solution for vibro-acoustic diagnostic and analysis.

Direct import of 3D models

All results are visualized on an interactive 3D model. The software can directly import a variety of standard file formats and has embedded tools to modify loaded files. File format standards from popular programs like CAD or Sketchup. Examples of format types are .obj, .stl, .3DS, .Shape and .dae.

Alternatively, if no model is availably for import, a fast method using a Structure Sensor to obtain a detailed 3D model can be offered. The Structure Sensor can be used either with an iPad or PC and provides a 3D model in a directly compatible file format in a matter of minutes. The software also allows for the use of Apple's LiDAR sensor.

Acoustic Shape licenses

	LITE	STANDARD	PRO
Data recording	✓	✓	✓
3D Tracker (incl. live tracking)	✓	✓	✓
Support 3D objects texture mapping	✓	✓	✓
Sound pressure, 3D particle velocity, 3D sound intensity (incl. active and reactive fields)	✓	✓	✓
Troubleshooting Tools	✓	✓	✓
Multi-view tools for result analysis and comparison	✓	✓	✓
Colormaps based on planar sections	✓	✓	✓
Advanced colormap display (3D wrapping and spherical sections)		✓	✓
Multi-panel grouping, comparison and sound power ranking		✓	✓
Full export options (incl. *.csv, *.mat, ParaView and ACTRAN)			✓
Advanced troubleshooting, section time export, cross-processor			✓
Reference sensor-based displays			✓
Order analysis			✓
Compatibility with Universal Robot scanner			✓

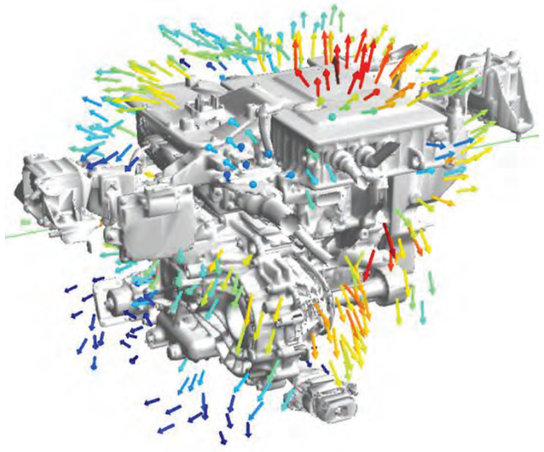
Scientific Paper

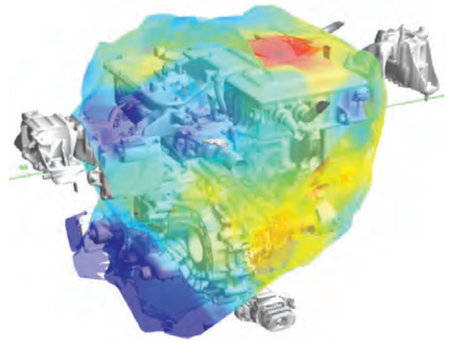
SOUND PRESSURE PREDICTION OF AN ELECTRIC POWERTRAIN PERFORMED IN AN ENGINE DYNO TEST CELL USING 3D SOUND INTENSITY

E. Güven, D. Fernandez-Comesaña and T. Marini Storani

Abstract

Increasing pressure from the consumer market challenges automotive OEMs to meet customer expectations for NVH performance in ever more efficient ways. The rapid development pace of new vehicles results in short development cycles, where vehicle testing is kept to a minimum and preferably focused on individual sub-components. Complex elements, such as electric powertrains, are often designed to be compatible with multiple vehicle models, so as to maximize their usage while effectively reducing their development cost. As a result, a thorough characterization and understanding of these primary components are key to preventing potential issues. From an acoustic perspective, this scenario can be simplified by characterizing the vibro-acoustic emission of the source and the propagation paths toward the car passengers separately. A detailed characterization of the sound field around the engine will not only help predict the sound pressure perceived inside the cabin but also understand the impact of individual elements on the noise emitted. In this paper, we present a novel technique using multiple 3D sound intensity probes and a three-dimensional tracking system to measure the sound radiated by an electric powertrain during Wide-Open Throttle (WOT) on a dyno test cell. The 3D radiation data is then combined with acoustic transfer functions measured reciprocally on a full vehicle. This approach enables the synthesis of the individual contributions of the Electric Drive Unit (EDU), junction box, and inverter for a particular vehicle model but it can also be extended to other vehicle implementations just by measuring a new set of acoustic transfer functions. Experimental results are compared with full-vehicle measurements performed on a roller test bench. Results demonstrate the effectiveness of the proposed approach, enabling the prediction of key acoustic features induced by the powertrain inside the cabin while identifying the main areas responsible for the noise emission on critical excitation bands. Furthermore, the usage of order and frequency filtering on the 3D sound visualization maps was proven to be very useful for troubleshooting purposes. In conclusion, the proposed methodology can be used to improve the refinement process of an electric powertrain in an easy and intuitive way, enabling it to identify areas of high noise radiation and predict potential problems of an electric powertrain mounted into different vehicle implementations.





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