



POWERFUL TOOLS FOR ALL
ACOUSTIC AND VIBRATION APPLICATIONS.

MEASURE. ANALYZE. ASSESS. MANAGE.

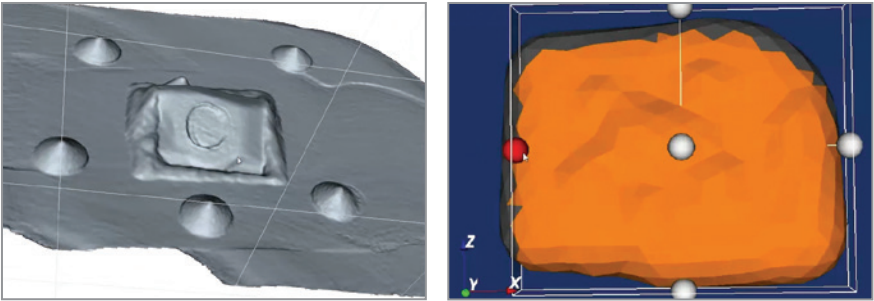
ABOUT US

Müller-BBM VibroAkustik Systeme is part of the Müller-BBM group, an engineering company based near Munich in Germany, founded more than 50 years ago. We are an internationally operating company providing engineering services and sophisticated technical products and software at the highest level. More than 1200 employees worldwide contribute to the company's success every day. Our active employee participation model (Müller-BBM is 100% employee owned) guarantees our independence and enables us to operate in a sustainable way.

We provide market-leading measurement and analyzing tools in the fields of acoustics, vibration and strength. With PAK, our test bench acoustics measurement system, users have the opportunity to combine suitably configured hardware and software (on a computer or a smart device) for your **data acquisition**. In doing so, users benefit from being always ready to measure as well as direct graphical representation of the measurement data. **Data analysis**, simulation, assessment, and modification tasks are completed in a clear and explicit way, during or after the measurement. **Data management** is highly efficient and uses the latest cloud technology, allowing worldwide access to the corporate data network.

Our tools for you:

Rotational Analysis <ul style="list-style-type: none">• Order Analyses• Kalman Filtering• Torsional Vibration• Angle-based Analyses• Combustion Analyses	Classical Acoustics <ul style="list-style-type: none">• Reverberation Measurement• Sound Intensity• Sound Power• Octave Analyses• Sound Localization• Exterior Noise	Psychoacoustics <ul style="list-style-type: none">• Sound Design• Online Filtering• Hearing Comparison• Jury Validation• Engine Roughness	Structural Analysis <ul style="list-style-type: none">• Impact Measurement• Shaker Measurement• MIMO, SIMO• Operational Deflection Shape Analysis• TPA, TPS, CTC, PCA• Matrix Inversion
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Robot based 3D intensity measurement with automatically generated model of the test object

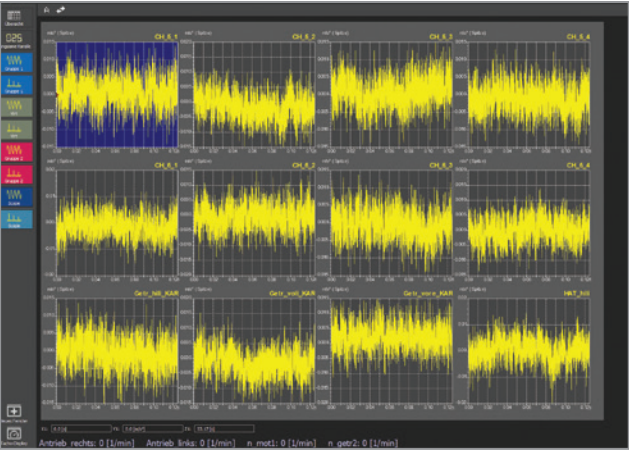
Our System in Action:

Whether it's a **mobile** system or synchronized larger system at a **test bench**, we always have the appropriate solution for you. Our modular system comprising of measurement hardware and analysis tools, offers you the opportunity to grow along with the changing requirements for your tasks. The PAK system is an established and reliable partner at NVH test benches for the engineering of:

- Entire vehicles
- Power trains
- Components

Measurements acquired by our PAK system can be triggered via connected host computers. It was especially designed this way for a seamless test bench integration. We support all common sensor types for the measurement of **acceleration, power, strain, airborne noise and structure-borne noise** as well as **the precise recording of rotation**. Due to the dynamic nature of these parameters, it is essential that both analog and digital bus data (**such as EtherCAT®, CAN and FlexRay™**) are sampled at exactly the same time to ensure accurate representation of the environmental conditions.

Boasting an extremely **powerful graphics**, PAK is a valuable and performant tool to help keep track of your measurement in every situation. In order to perform efficient mobile measurements, important data needs to be displayed quickly and clearly. New PAK live technology assists users with this and even enables them to undertake the measurement without any additional computer software. For extensive measurements at the test bench, PAK offers fixed processes that guarantee solid and sustainable accomplishment of measurement tasks. Regardless of the application, our emphasis is on an open concept. All data generated with PAK automatically can be stored in the open **ASAM ODS NVH ATF/XML standard**.



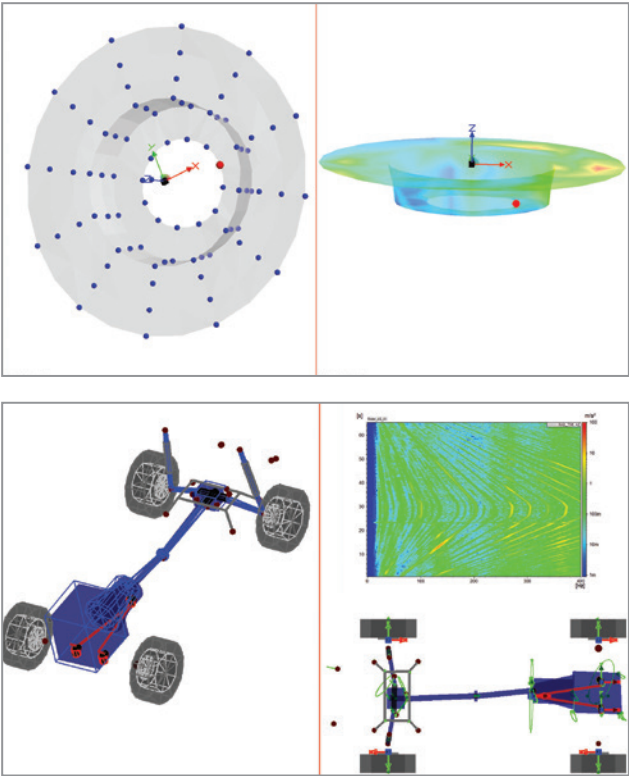
PAK scope: All channels at a glance



STRUCTURAL ANALYSIS

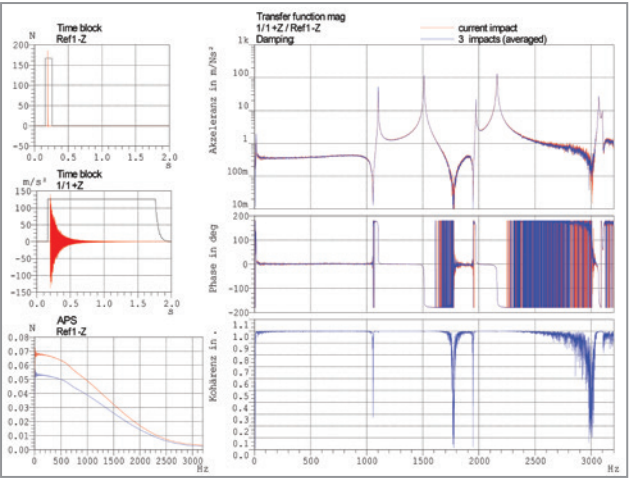
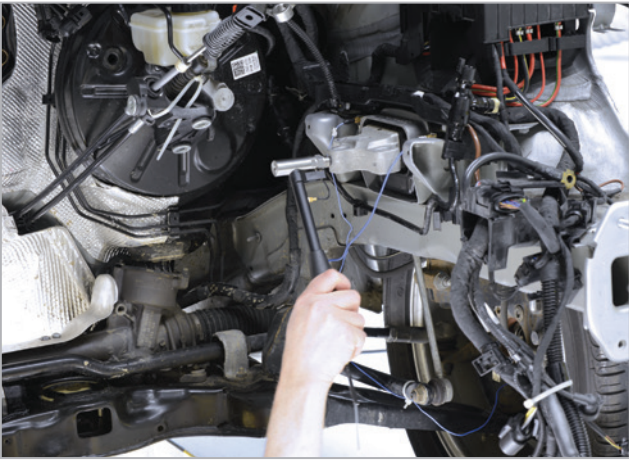
Structural analysis is an essential to the development, simulation, validation and troubleshooting process and an integral element within the automotive industry. The application field is broad ranging from power train and other active components, to the entire body. PAK provides various tools tailored for these specific and varying tasks.

Applying the Operational Deflection Shape Analysis provides a first insight into the vibrational properties of a structure. First operational measurements are conducted at operating points with and without abnormalities before being animated. In this way the mechanisms between the excitation and response position as well as the resulting vibration behavior at critical frequencies can be investigated. This can be done for both translational and rotational vibration.



Operational deflection analysis of a brake disk and power train

A structure's vibrational behavior is determined by the natural resonances appearing at distinct frequencies. By means of modal analysis, the vibrational behavior can be thoroughly investigated and transformed into a modal model. A structure is therefore excited with either an impact hammer or a shaker in order to compute the transfer functions. Due to the low preparatory effort required, the **PAK impact measurement** is the preferred tool for troubleshooting. It is possible to determine whether the excited subsystem can be modified in order to avoid the resonance, or if the more complex paths of propagation should be investigated. The PAK system provides specially designed workflow-oriented tools for both impact and shaker measurements.

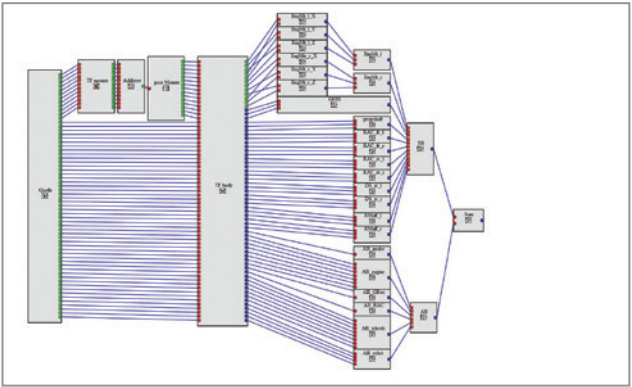


Impact measurement on a test object



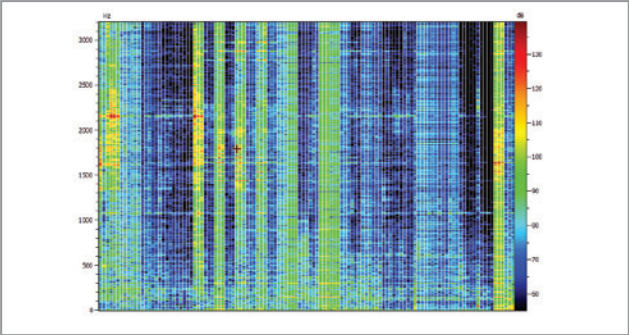
Exterior noise test bench

In order to investigate more complex structures consisting of both active and passive subsystems, such as engine and body, PAK offers an extensive package for **Transfer Path Analysis (TPA)**. A comprehensive physical description of structures can be achieved with classical TPA methods, e.g. based on the **Matrix Inversion**. This determines the forces between the subsystems and the transfer paths themselves. Individual components can be described in detail by applying the blocked force approach or in-situ measurements. These insights and physical properties can be subsequently applied in the simulation process and are essential for further validation during development. The so-called **Operational Transfer Path Analysis (OTPA)** or Contribution Analysis, also forms part of our wide range of TPA approaches and is frequently applied when troubleshooting, such as during the localization of unwanted or disturbing phenomena in exterior noise development. Contributions of individual sources and

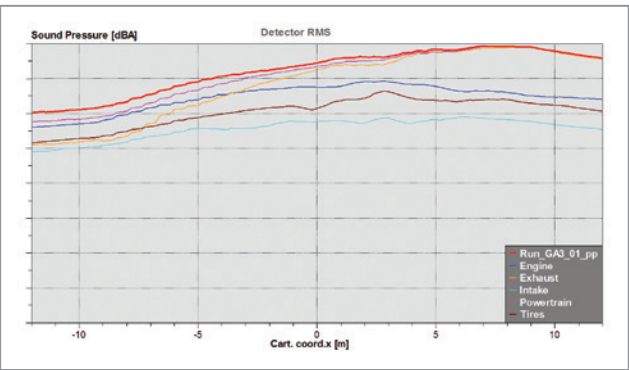


Transfer path network

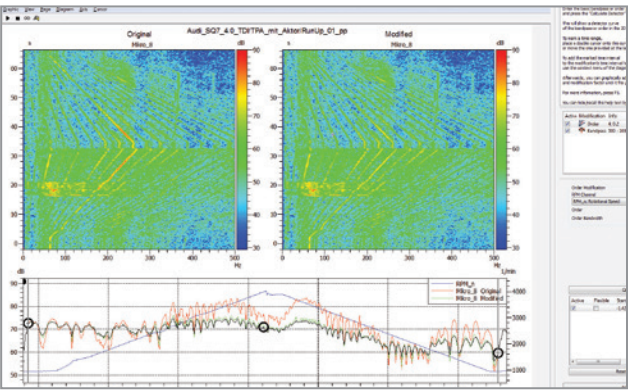
transfer paths can be ranked and indicate possible modifications. The **Response Modification Analysis** provides a more detailed insight. Following targeted adjustments of the response signal, the modification of individual sources is suggested. In this way a sensitivity test for the entire system is made.



Multi-channel overview



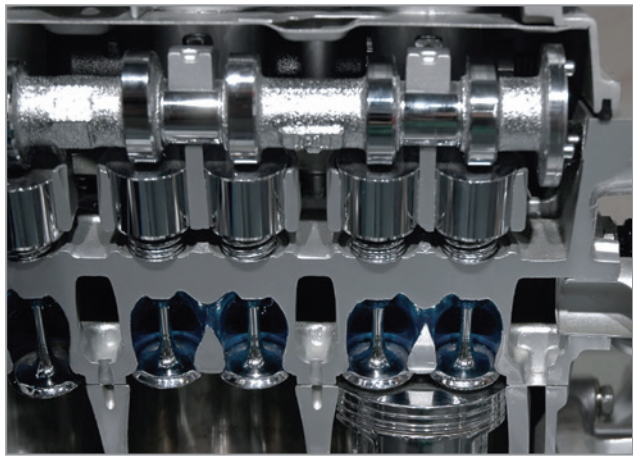
Contribution Analysis at an exterior noise test bench



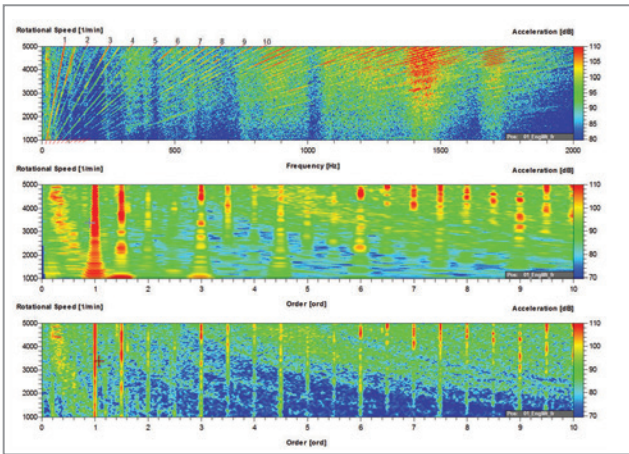
Example of a Response Modification Analysis

ROTATIONAL ANALYSIS ON POWERTRAINS

Each powertrain, either on a combustion or electric engine, usually comprises of various rotating parts, such as the clutch, gear and crankshaft. Rotational and torsional vibration propagates along the powertrain and is transmitted to connected components.

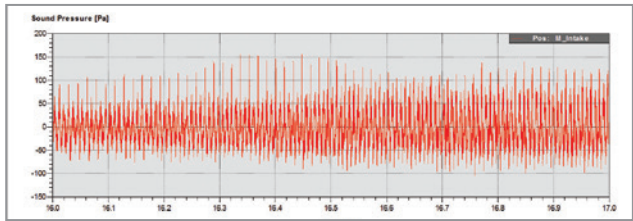


A successful rotational analysis requires a highly precise rotational speed acquisition with a high number of pulses per revolution. Besides the exact measurement of rotational speed it is now also possible to exactly determine the angular velocity and then consequently the torsional vibration of the rotating part. This for instance allows for the thorough design of the dual mass fly wheel between the engine transmission coupling.

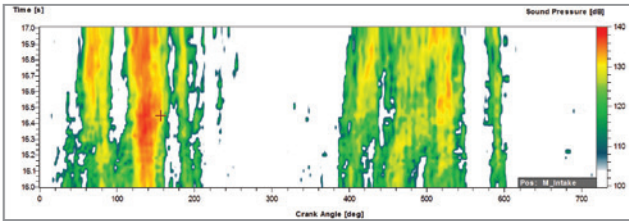


Order analysis with and without digital order tracking

This high precision also allows for the transformation from the time domain into the angular domain. While the torsional vibration is only depending on the rotational speed, a wide range of phenomena can only be observed at distinct angular positions in the system. These include the combustion process, piston travel and the fuel injection system. The analysis requires the time raw data, rotational speed and the so-called OT signal, which indicates the initial position of the rotating system, e.g. the ignition. The time raw data is now aligned to the angular positions along one or multiple duty cycles, allowing the assignment of an angle to each signal. Hence, knocking noise resulting from a damaged gear can be precisely localized and isolated.



Time raw data

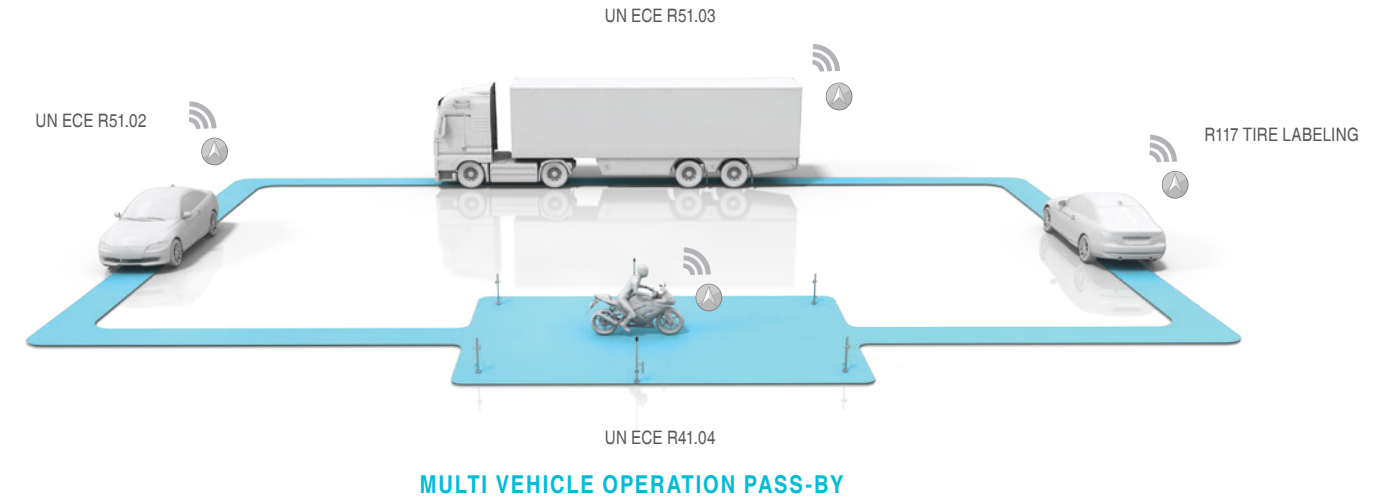


Localization of knocking sound using the revolution signal at the angle domain

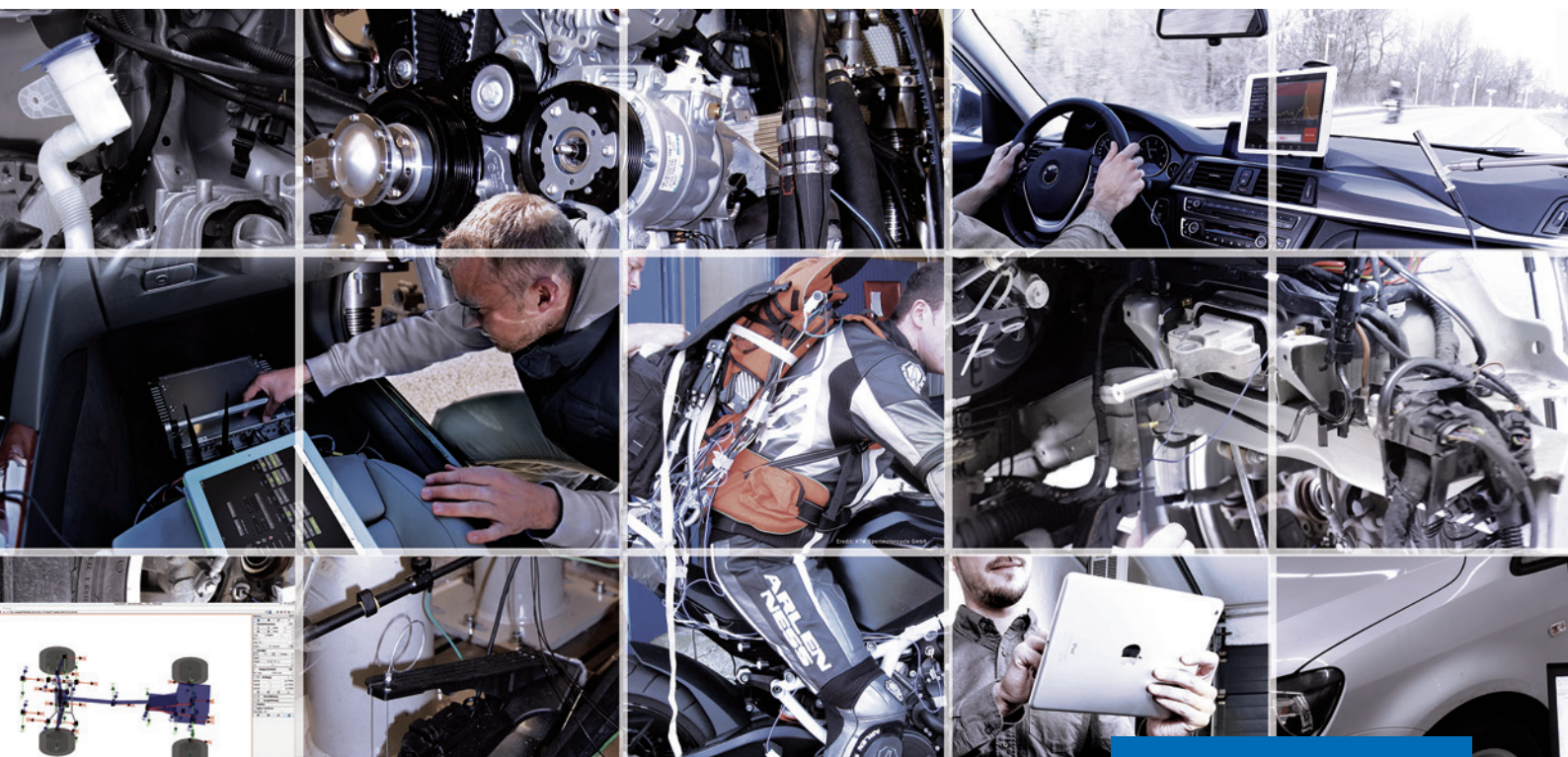
EXTERIOR NOISE DEVELOPMENT

On the exterior noise test track the new PAK pass-by application assists users with the measurement execution according to standards such as UN ECE R 51.02/3 (car/truck), R 41.04 (motorcycle), idle noise (51.02/3), horn noise, ASEP (51.03), tire roll noise, R117 tire labeling and compressed air noise – even as a one-man operation. PAK live technology enables the measurement of **different vehicles at the same time on the same track**. Benefit from the assistance offered by PAK in complying to set criteria and from the connection to your own database. Here, measurement duties are linked with the relevant vehicles; while inputs and results are forwarded to the relevant recipients.

PAK also provides the appropriate tools for the development of exterior noise on and off the track. In combination with **OTPA** and acoustic **Sound Localization**, PAK is an efficient tool for identifying the dominant sources in the exterior noise level. Additional tools, such as the measurement of the time signal of the single sources of the exterior noise, complete the analysis portfolio. Different sets of tires can be varied and revised in order to determine the changes in the exterior noise. During this process the PAK system can be connected to the test bench host computer, in order to further automate operation at the test bench.



BOOST YOUR WORKFLOW WITH A COMPREHENSIVE APPROACH FROM TEST PREPARATION TO DATA MANAGEMENT



CONTACT US NOW.

MBBM
MÜLLER-BBM GROUP

About Us

Müller-BBM VibroAkustik Systeme provides test solutions for the Aerospace, Aviation and Defense industries in the areas of high speed data acquisition and shock, structural dynamics, fatigue analysis and turbine testing.

We are leading in vibroacoustic measurement technology focused on the interpretation of dynamic and static parameters for the experimental test market. Our tight partnership with the industry and acknowledged expertise in acoustics and vibration results in innovative solutions that seamlessly integrate into laboratory, production and field environments.

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