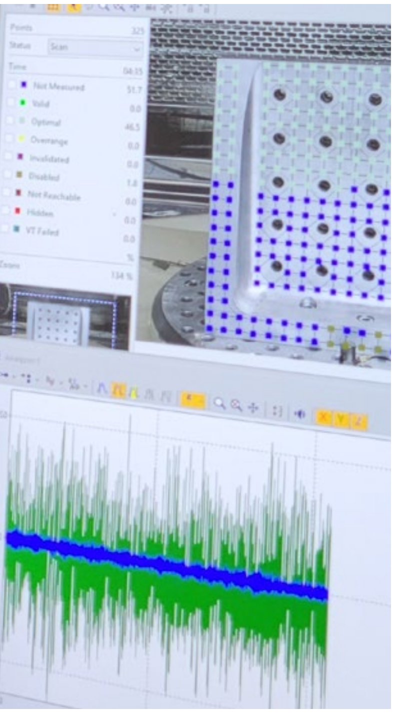


Determining the resonance frequency
by means of hammer or shaker excitation
Application note

Scanning vibrometers, such as the 3D laser Doppler vibrometer from Polytec, are frequently used by development and research departments in product development to analyze the dynamic behavior of components and systems.

Experimental modal analysis (EMA) is an established method for investigating the structural dynamic properties of mechanical systems in the aerospace, automotive, construction and household appliance development sectors. The determined resonance frequencies and vibration modes of the component enable not only an understanding of the structural dynamic properties but also the optimization of product designs or the validation of simulations carried out.

The following describes a measurement setup for determining the resonance frequencies and vibration modes of a component using the excitation of a modal hammer or electrodynamic shaker.

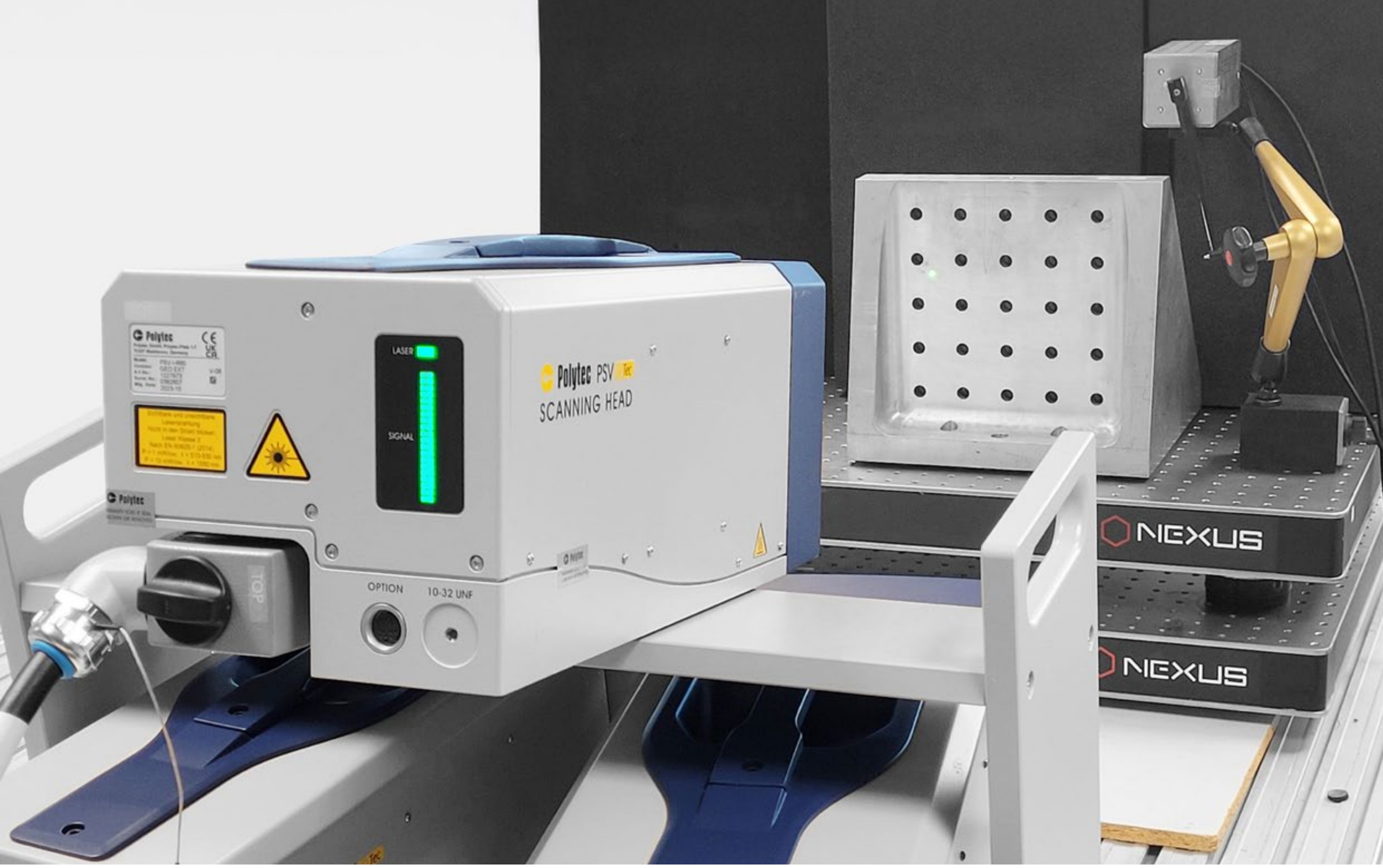
Measurement setup

The measurement setup consists of an aluminum component carrier that serves as the test specimen. The test specimen is excited in a defined manner by an automated modal hammer (NV-TECH SAM1) or an electromechanical shaker.

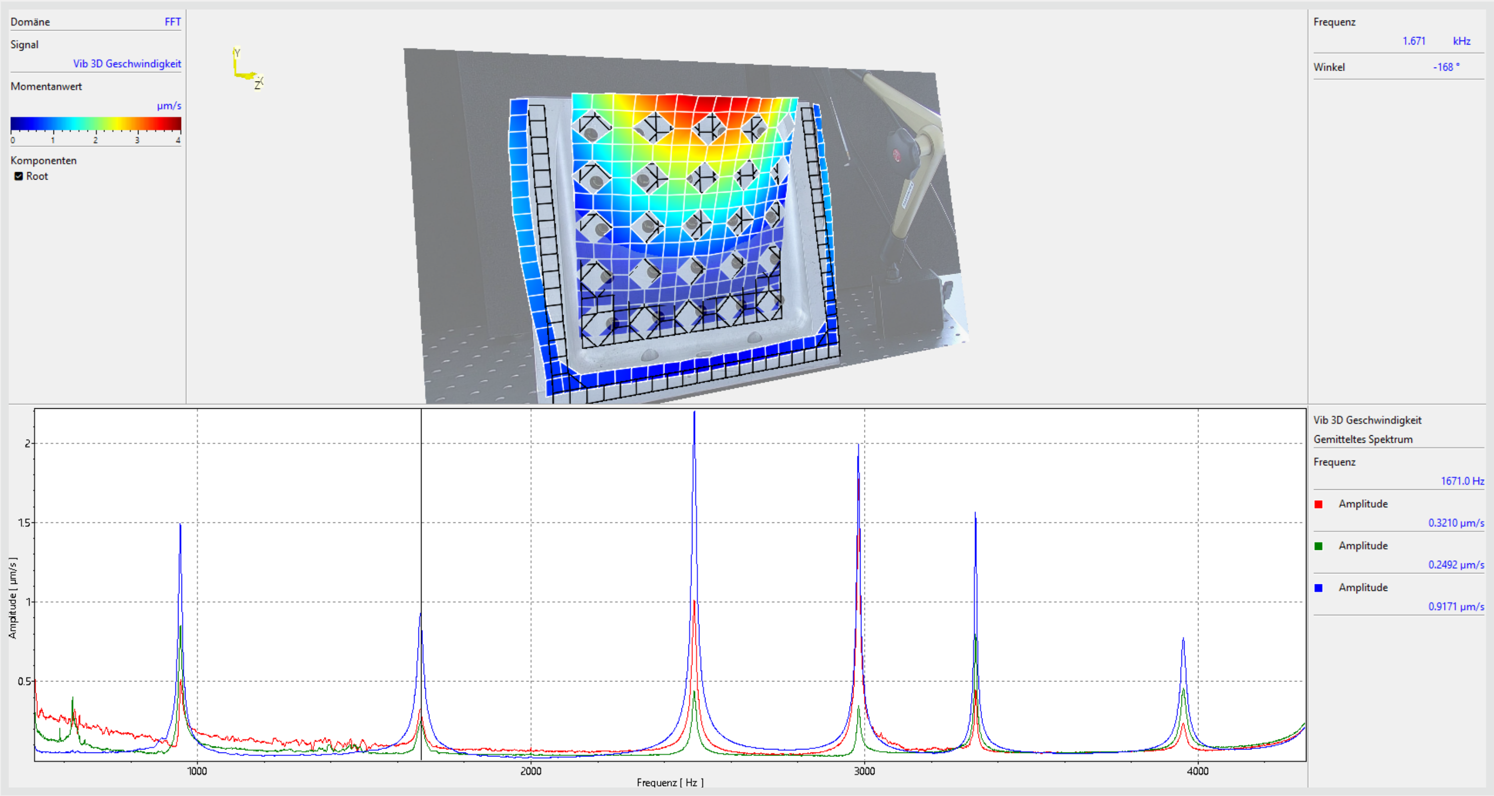
The automatic modal hammer NV-TECH SAM1 shown in **Figure 1**, is mounted on the articulated arm and generates a reproducible broadband excitation of the test object with the same force every time.

The vibration data is recorded and processed using the highprecision, non-contact QTec 3D scanning vibrometer. The vibration data recorded over a large area enables the resonance frequencies occurring to be identified. For each of these resonance frequencies, the animated 3D operating deflection shape can be displayed after the measurement, as shown in **Figure 2**.

If required, the Eigenfrequencies, damping values and mode shapes are then determined using the PolyWave modal analysis software.



1 *Test setup for resonance frequency determination using automated hammer excitation on a vibration-decoupled table. A Polytec QTec 3D scanning vibrometer can be seen in the foreground.*



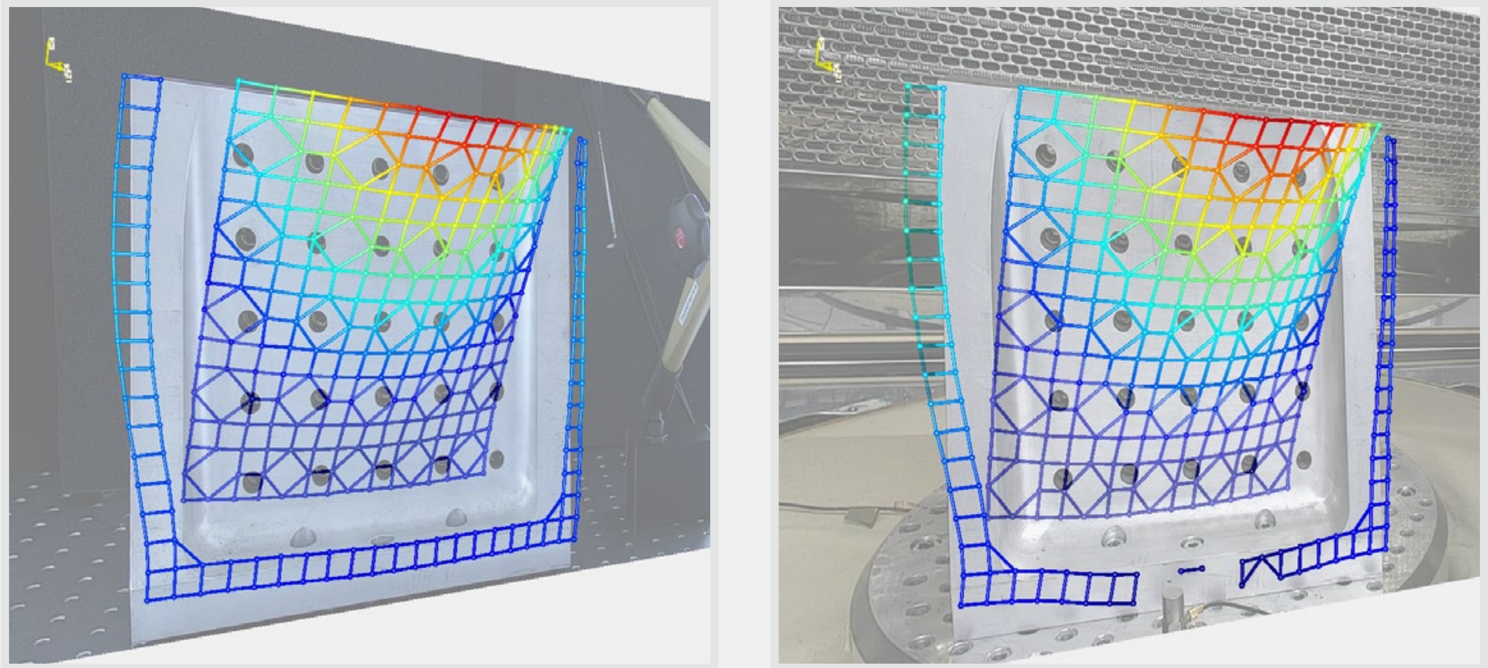
2 *Result of the experimental modal analysis. The operating deflection shape at 1.6 kHz is shown at the top, the resonance frequencies occurring are visible at the bottom. The deflection shape can be displayed for each resonance frequency.*

3 *Test setup for experimental modal analysis using an electromechanical shaker at Beck-Messtechnik, a renowned measurement technology specialist for environmental simulation. A QTec 3D scanning vibrometer can be seen next to the shaker. The PSV measurement and evaluation software is visible in the foreground.*

As an alternative to exciting the component with an automatic modal hammer, the excitation can also be carried out with an electromechanical shaker, as shown in **Figure 3**.

To do this, the component is mounted on the shaker, as shown here at Beck-Messtechnik, and its structure is excited with a broadband frequency spectrum.

If we compare the operating deflection shape at a resonance frequency of 1672 Hz, **Figure 4** shows very good agreement between the mode shape excited with a modal hammer (left) and the mode shape excited with a shaker (right). In contrast to broadband hammer excitation, different signals can be used for excitation with the shaker. For example, in addition to broadband excitation using white noise, the test specimen can be excited with a sine sweep (higher energy input at the individual excitation frequencies) in order to analyze the natural frequencies more precisely.



4 *Identical operating waveforms at 1672 Hz despite different excitation: Hammer (left) and shaker (right).*

Results & conclusion

Determining the natural frequencies of components by means of shaker measurements or automatic modal hammer enables the reliable identification of vibration modes.

The measurements show that the shaker and the automatic modal hammer are suitable excitation methods for determining structural dynamic properties. Both methods have their own advantages. The automatic hammer excitation can be regarded as mass-free and is therefore particularly suitable for lightweight components and high frequencies in combination with laser vibrometers, which also measure mass-free. Shakers allow shorter measuring times and are more flexible in the excitation form.

Both methods in combination with scanning laser vibrometers offer a valuable basis for further investigations and optimizations in structural design, both in development and in testing, and the results obtained can be used to optimize and validate numerical models.

QTec Laser Doppler vibrometers with their innovative multichannel interferometry enable high-precision, non-contact vibration measurements without the need for surface treatment. Thanks to the patented QTec® technology, measurements with an excellent signal-to-noise ratio are also achieved through the panes of the climate chamber. This leads to shorter measurement times and enables precise measurements on difficult or moving objects.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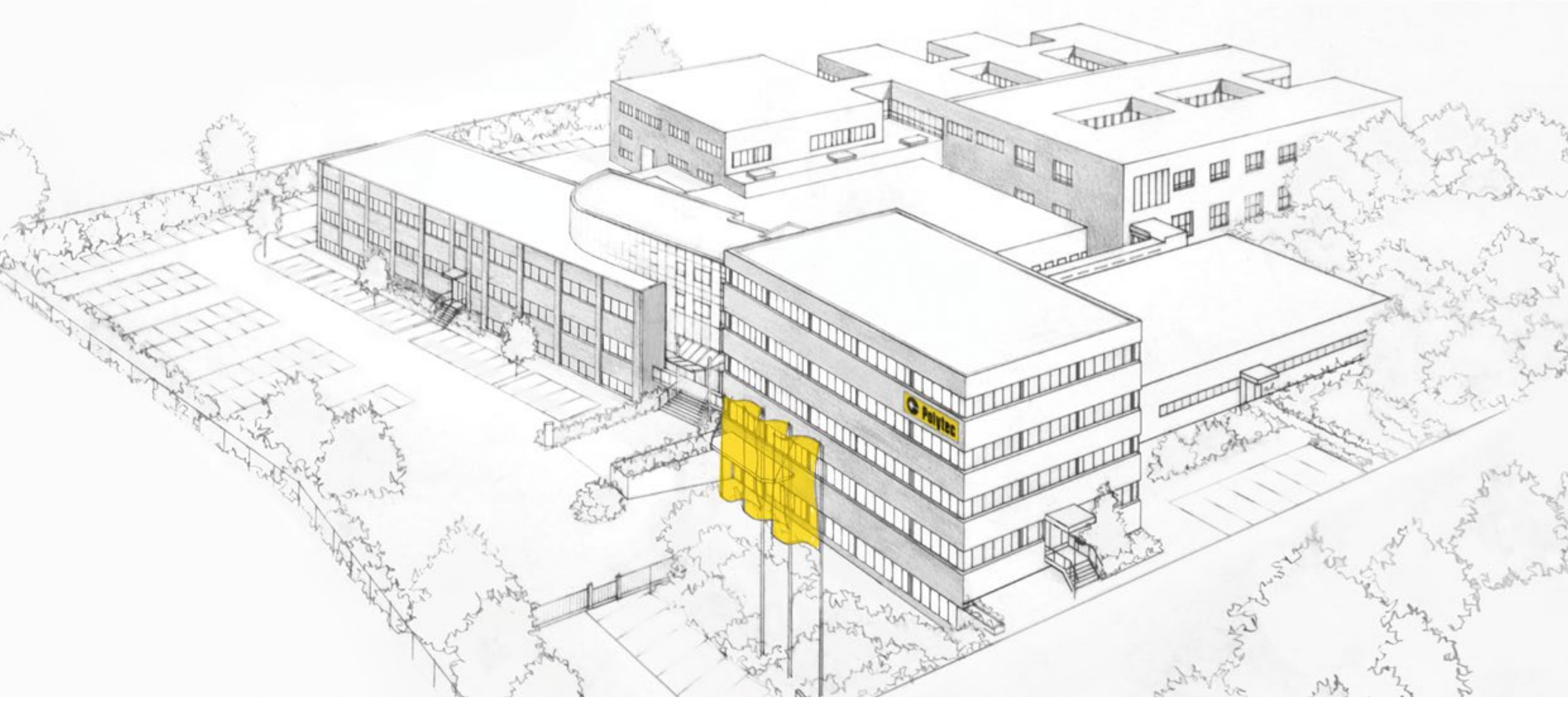

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